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NATURE

A WEEKLY JOURNAL OF SCIENCE

"To the solid ground
Of nature trusts the Mind that builds for aye"—WORDSWORTH

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CENTRAL AND LOCAL GENERAL INFORMATION SERVICES

AS the Royal Society Conference on Scientific Information closes, it is not inappropriate to consider the wider questions of the diffusion of information in general. The debate in the House of Commons on May 13 on the Civil Estimates for the Central Office of Information covered a wide field; from one point of view it was of interest on account of the statement which it drew from the Lord President of the Council, regarding information services and publicity organisation of the Government. That statement should do something to dispel the confusion which, as the debate itself indicated, still persists between a fact-finding organisation and that concerned with the dissemination of the information collected. Of the first the Economic Information Unit is typical, being concerned to supply the Government with information on the broad facts of the economic state of the nation and the economic problems of the world in relation to Great Britain.

While the Central Office of Information also deals with economic policy and exposition, working with the chief planning officers of the Central Statistical Office, with the Economic Section of the Cabinet Office and with the economic Departments of State, the research aspect of its work is less pronounced than in the Economic Information Unit, and the emphasis is rather on exposition. There can be no serious question about the need for the research aspect of information or intelligence work: the questions are rather whether there is enough of such fact-finding as a basis for policy, whether the departments are as active in this field as they should be, how best to correlate the work of the individual information units which clearly the departments must possess, and whether the work is of the highest quality and its results made known throughout the whole organisation of government with the swift efficiency that is desirable. It is on the aspect of dissemination that criticism has centred. Is that dissemination sufficiently effective to avoid unnecessary duplication? Does it reach the official who needs it sufficiently promptly? And does it reach the general public in a way that ensures their co-operation and understanding of the issues involved?

On the internal aspects of dissemination little was said in the debate. Criticism centred rather on the weakness of the relatively small amount of Central Office of Information publicity directed towards the general body of the public. Some of the criticism is obviously to be discounted. Every step taken by a party in power to direct and control the sources of public information is naturally watched with healthy suspicion. However anxious a Government may be to avoid using departmental channels of publicity for propaganda, it is never easy to avoid the danger; further, public relations officers can, in the nature of things, easily become a cloud of witnesses for the defence of Ministers.

There can be little doubt that the Central Office of Information justifies its existence, and that the departmental information services and public relations officers are doing valuable work. The importance of such services was well indicated in a recent broadsheet issued by Political and Economic Planning. None the less, they call for friendly but searching scrutiny; while there may be much to praise, there is still room for improvement in the standard as well as the cost of the work, and Mr. Herbert Morrison seemed not indisposed to admit the importance of quality.

It can be taken as common ground, as Sir D. Maxwell Fyfe indicated, that each Minister should be responsible for the information policy of his own department with the aid of a small but highly trained information staff; that there should be adequate means for the co-ordination of both home and overseas information services so as to ensure consistency of policy and presentation; and that a central Government agency should carry out on behalf of departments most of the technical and production functions. What is at issue is rather the use made of these organisations, and the quality of the work. In particular, there is the question how far the work of informing the public, for example, in foreign affairs, should be left to Government publicity organs rather than to the Press. That question may well be the fundamental factor behind much of the criticism directed against the shortcomings of Government publicity organisations, and the criticism would be less sharp were it not for the way the Government's economic policy is cramping the free discussion and reporting of public affairs in the Press.

To complete the picture which the Lord President of the Council gave on May 13, it is necessary to turn to the statement Sir Stafford Cripps made on June 1 giving the membership of the Panel on Technical Information Services and its terms of reference. Under the chairmanship of Dr. A. King, of the Lord President's Office, the Panel is to review existing information services for distributing scientific and technical information, to consider what improvements can be made to ensure a rapid and wide dissemination of such information to industry and to make recommendation to the Committee on Industrial Productivity accordingly. That is only one aspect, and a highly specialized one, of the question, and indeed goes beyond the field of Government publicity in the strict sense; but it will be surprising if the Panel does not comment on the way in which the Government's newsprint policy retards the free dissemination of scientific and technical information through the scientific and technical Press.

It is true that certain concessions have been made and the position is easier than it has been. No scientific man, however, can be satisfied with the present position of the scientific and technical Press in Britain, whether in respect of periodicals or of books. The suspension of periodicals in the fuel crisis of 1947 is only one of a number of Government actions which engender distrust of its good faith in regard to freedom of communication; nor can scientific and technical publications be sharply distinguished from the general body of the Press. It is precisely because the Government has such a poor record in this matter that so much bitterness h been manifest in recent debates on the supply newsprint and of books.

The Government, in fact, has still to show tha is sincere in the support which it gave at Geneva freedom of information. The effect of the pros situation is well displayed in an article in *The F nightly Review* of June by W. C. Andrews. article deserves to be studied by everyone concer with the preservation of freedom of communica Mr. Andrews shows why newsprint cannot be trea as just another material commodity, and some least of the current criticism of Government info ation services is inspired by resentment o apparently lavish supply of paper at their disposa the face of the drastic curtailment of the s available for public discussion and comment in independent Press as compared with a decade It cannot be too strongly emphasized that t restriction, even if it is due to economic motives alone, is an effective form of censorship. Important events are reported imperfectly or not at all, and the formation of sound opinion is severely handicapped. Nor is that all. Mr. Andrews indicates how adverse are the repercussions on the functioning of democratic institutions, for example, local government; and the interim report of the Consultative Committee on Publicity for Local Government presented last autumn might well be studied afresh from this point of view. The Committee was agreed that much more needs to be done to stimulate publicity at both national and local levels, and it emphasizes, like Mr. Andrews, that the problem is mainly one of widespread lack of knowledge leading to apathy. The report is, in fact, like his article, a commentary on the aphorism of Junius which Mr. Andrews quotes: "The liberty of the press is the palladium of all the civil, political and religious rights". Local authorities have an undoubted duty to make information public by the most suitable means, and some of them have been justly criticized for failure to do so.

The report suggests that every local authority should review all its channels of communication with the public of its area and consider how these can be improved and extended. It does not advocate the expenditure of large sums on centralized publicity. Rather the Committee believes that local authorities can carry out consistent and effective publicity without elaborate machinery and heavy expenditure. It does hold, however, that much more could be done to educate officials of all grades in the right way of dealing with members of the public, and that the public relations spirit should permeate the whole organisation, members as well as staff. It insists also that one of the main needs is the fullest possible use of the facilities offered by the local Press for supplying regular information to the local people. No policy for improving publicity for local gover ment can, in its opinion, be effective unless ev effort is made to secure the co-operation of lo newspapers.

This section of the report is of particular intere for it is here, as Mr. Andrews indicates, that Gove ment policy has proved most hampering and is ndeed tending to frustrate the functioning of mocracy. Opportunity for public comment and bate is essential to secure action in accordance ith the facts of a situation and not on lines dictated prejudice or vested interest. It is just as true at local as at the national level that scientific and hnical factors must be explained to the public. A sely related matter is the control of nationalized dustries. The recent resignation of Sir Charles id from the National Coal Board has given warning the danger that due weight may not be given to the hnical factors in the reorganisation of this national- industry; unless some means of public discussion found, there is real danger that a fresh set of tional interests and prejudices will arise to obstruct technical reorganisation that the public interest mands.

If the scientific man or technical expert, such as the mining engineer, is to be given the executive uthority he needs to carry out the technical functions entrusted to him, the co-operation and support of the public as well as of the other workers in the industry concerned will often be required. For this reason alone the question of the control of nationalized industry and the responsibility of such industries to Parliament is a matter of close concern to him. It is evident that Parliament itself is much exercised over the special status of the boards of nationalized industries, and that while there is no desire to interfere with matters of day-to-day administration, there is a desire for fuller information on policy and for opportunity for public criticism. The Speaker indicated in the House of Commons on June 7 that he was prepared, if it was generally approved, to exercise his discretion to direct the acceptance of questions asking for statements to be made on matters about which information had been previously refused, provided that, in his opinion, the matters were of sufficient public importance. Public importance is one of the tests for motions for the adjournment of the House and was not in his experience an unduly difficult test to apply. This suggestion the Government is prepared to accept; it is probably to be welcomed as affording further time for the whole question of public information and public relations to be re-examined.

What must be remembered, however, is that any such procedure inside the House of Commons will still be insufficient while the newsprint position restricts the Press from reporting such questions and debates at reasonable length. We come back to the point with which we started, that freedom of information and communication are an essential element in the functioning of democracy as well as in the application of knowledge to public affairs and the advancement of science; it is impossible in the presence of a direct censorship or of that indirect censorship which the absence of adequate supplies f paper or print imposes. There are few members f the Government who, despite obvious touchiness n regard to criticism, can fairly be suspected of an liberal attitude on this question of information and dependent comment. None the less, in spite of the work of the British delegates at Geneva on the resolution that freedom of information is a fundamental right of the people and the touchstone of all the freedoms to which the United Nations are dedicated, the Government's attitude on the question of imports of newsprint still gives rise to serious concern. Such resolutions are hypocritical unless they are accompanied by practical evidence of concern to provide the essential means for a free Press, technical and scientific, as well as general, to discharge properly and efficiently its function of keeping men and women informed on advances in knowledge and on the issues involved in every aspect of public affairs. Nor can any Government information service, however efficient and free from party bias, undertake that task without the support of an independent Press which has also the resources for acting as an efficient instrument of information.

THE SEARCH FOR THE GERMAN ATOM BOMB

Alsos

The Failure in German Science. By Prof. Samuel A. Goudsmit. Pp. xiv+260. (London: Sigma Books, Ltd., 1947.) 15*s*. net.

PROF. GOUDSMIT has written a racy account of the part played by the Alsos mission in the investigation by Allied intelligence of the German uranium projects, which makes very good reading. He tells some first-class stories; the one about the radioactive wine dispatched by air to Washington deserves to become a classic; and he has some interesting things to say about the methods used by his unit and about security in armament research. His book necessarily treats only part of the subject, namely, the work of scientists who accompanied the advancing armies from the time of the liberation of Paris until the end of the War. It is to be hoped that it will some time be possible to release an account of earlier investigations, of the extent to which it was possible for military intelligence to keep track of the relevant activities of German scientists, and of the conclusions that were drawn. It was not until the occupation of Strasbourg that the Alsos mission obtained certain proof that the Germans were far from obtaining either an atomic bomb or radioactive poisons; but whether at this or at an earlier stage of the War fear of these developments was a potent motive in Allied strategy, or whether enough evidence existed to show that they were most unlikely, Goudsmit's account does not say.

But to the reviewer by far the most interesting part of the book is the description of Goudsmit's meetings with the German scientists, and his discussion of their motives in working or not working for the German war machine. This is a subject of profound interest and importance, for the question of the relation of the scientific worker to the State is one which every one of us has to face, even though we hope that the problem will not soon be again so acute as it was in the Third Reich. It is of particular importance also in connexion with the re-establishment of normal relations with the scientific workers of Germany. For a German professor invited abroad acquires thereby some prestige in his own country, and it is widely felt in Britain that this prestige should not be conferred where it is not deserved.

But a discussion of the motives of German scientists concerns the actions of living men, who can and do state their side of the case, as has Von Laue recently* and Heisenberg in an article in *Nature*† on the German work on uranium. The subject is one likely to arouse the bitterest emotions, both in Germany and among those in Britain who have suffered personal loss in the War or at the hands of the Gestapo. It is therefore particularly necessary that Allied scientists, if they approach it at all, should do so with all possible objectivity, quoting, if possible, from documents rather than hearsay, and judging a man only on the basis of generally available evidence. In this respect it is possible to offer one criticism of Goudsmit's book. It contains a witty description of the scene among the German scientists interned in England when they heard the news of Hiroshima. First they did not believe it possible; then they saw how it was done, and were ashamed that they had not thought of the method themselves; and finally, he says, they built a rationalization for their failure, by denying that they had ever tried to make an atomic explosive.

How does Goudsmit know all this? Unless it was by questioning the scientists afterwards, it must be assumed that some record of the conversation was obtained. In that case, Goudsmit's conclusions would have been more convincing if the record could have been published, rather than this dramatization of it. Perhaps this is at present impossible; but in the circumstances this record of the motives of the German scientists reads rather like a theory in physics based on unpublished experimental facts, so that it is impossible to judge how valid or fair the conclusions are.

The truth in a matter like this is unlikely to be simple. It is clear that German scientists were by no means so unanimous in their desire to work for the war effort as were the British and Americans. Some, of course, did so; others—a point which Goudsmit makes very well—wished to do so and were prevented by the stupidities of the Nazi organisation; others held aloof as much as possible. There also seems to have been, especially towards the end of the War, a rather cynical desire to obtain from the war machine facilities for scientific projects of fictitious military value, to "use the war to help science". To the men working on the uranium project, as the War drew to an end, it must have been clear, whether or not they realized the potentialities of plutonium or of a fast chain reaction with uranium 235, that no weapon for Germany could come out of their work. At that time it must have been true that the aim of their work was to obtain machines, or prestige, but not bombs. The innocence of the motives with which it was started is, however, less certain; no one who realized that a bomb might result from his researches can say honestly that he did nothing which might have armed the Nazis with atomic weapons.

It is doubtful, however, whether this question of motives in research is of lasting importance for the reputation of German physics. Many of us in Britain can realize only too well the strains to which a German scientist of integrity has been subjected; the conflict between the desire to stay and save from the Nazis something of German culture and the desire to escape to a free country; the reluctance to be an "armourer of Himmler and of Auschwitz", and the desire to strike back at the destroyers of Hamburg and of Dresden. In a few years time, when passions have cooled a little the welcome that a German scientist will find among his colleagues in the West should depend very little on the extent to which, under the stress of war, he worked on weapons. It is to be hoped that it will depend far more on his earlier record, on the opposition that he offered within and outside his university, at the time when opposition was still possible, to the steps that stifled freedom in Germany and made war inevitable.

N. F. MOTT

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* *Bulletin of the Atomic Scientists* (April 1948).

† *Nature*, **160**, 211 (1947).

THE FAEROES

The Atlantic Islands

A Study of the Faeroe Life and Scene. By Kenneth Williamson. Pp. 360+23 plates. (London and Glasgow: Wm. Collins, Sons and Co., Ltd., 1948.) 16*s*. net.

MR. WILLIAMSON has published a notable book on the Faeroe Islands, where he was stationed during the war years. He is the better qualified in that he married a Faeroese wife.

The Faeroes are a group of islands lying in the North Atlantic between Shetland and Iceland. There are more than twenty islands, covering an area of 541 square miles. Seventeen of the islands are inhabited and the population is 30,000, of which more than 5,000 live in the capital, Tórshavn. The people are of Viking stock, with a culture originally brought from Norway when the islands were settled in the tenth century. Even before they were colonized from Norway, the Faeroes were inhabited by Irish Culdees, who in the ninth century had retreats both on these islands and on the Vestmanna, an island group off the south-west coast of Iceland. It is interesting that there should be a Vestmanna in Faeroe also; the name means Isle of the West-men, as the Culdees were named. Many of the Faeroe inhabitants held positions in Denmark in 1939, and when the Germans invaded Denmark in 1940 a full tenth of the island race were cut off from their homeland.

The Faeroe Islands are mountainous, and most of the land lies at a height of between 1,000 and 2,500 ft. It is rough and rugged country, and on their west sides the hills often fall sheer to the sea from a height of more than 1,000 ft.; here are great colonies of sea birds, of considerable economic importance to the people. The moorlands provide grazing for sheep, and have a considerable proportion of peat, the fuel chiefly used. The chief rock is basalt. The annual rainfall is around sixty inches.

In winter the Faeroe hills are grim and desolate, vexed almost ceaselessly by ocean winds; in March come the golden plover, and the oystercatcher (*tjaldur*), which is the Faeroe national bird, the name of which adorns boats and businesses. The oystercatcher which appears often on the decorative needlework o the islands, is, like the whimbrel, only a summer visitor to the Faeroes. The author on page 41 gives a fine, poetic description of the song of the whimbrel above the wild island dales. Another migrant, the red-necked phalarope, is welcomed as being the precursor of the herring and is called (p. 84) "herring hen" for this reason.

When sailing in a boat at sea certain names are taboo (this was formerly the case in the Hebrides also). A knife is always 'the sharp one'; a clergyman is called at sea not a parson but *lundi*, the puffin. The Faeroese are great fishermen, and their smacks (p. 88) go as far as Greenland and Bear Island. During the worst period of the War, Faeroe boats brought no less than 75 per cent of the total catch landed in British waters: although the Iceland fishing boats refused to sail without air escort, the Faeroe boats carried on without it. Nearly one third of the active fleet was lost during the war years.

Mr. Williamson describes not only the bird life, but also the customs and folk-lore of the people. On page 234 is a most interesting story of seals laying aside their seals' coverings and assuming human shape. Almost the same story was at one time well known in the Hebridean island of North Uist, and no doubt was brought there by the Norsemen, who ruled the Hebrides until the Battle of Largs in 1263. Summer and the puffin arrive on April 14: between that date and August 24 no light is, or was, used in the houses in the evening, for 'early to bed and early to rise' is the motto in the Faeroe islands.

The book abounds in interesting bird notes and descriptions. On page 121 the bathing parade of kittiwakes to an inland lake throughout the daylight hours is described. This recalls a similar habit I observed on the island of Unst in Shetland. On page 128 is described what must be an unusual habit of Arctic terns, of collecting small fry dropped by puffins at the entrance to their nesting burrows. The puffins are afraid of the terns and scurry into their burrows when these light-winged birds hover near. This reminds me of the habits of the Lambay jackdaws, which during the guillemots' nesting season fare well on the fry the guillemots drop on their ledges. A patrolling jackdaw sees the gleam of the fry, drops down, and carries it off. The puffin is an article of food on the Faeroes. Upwards of 500,000 puffins are captured and eaten annually (p. 145) on the island group, and more than 100,000 young fulmars. They are mostly salted down for winter use. The fowlers believe that the puffin matures slowly and does not (p. 153) come to land the first summer after it is reared. On page 175 an inland-breeding colony of the puffin is noted. The young birds there when ready to leave the nest enter a small river and are carried on its waters during the night hours to the friendly sea.

There is a gannet colony on the Faeroes, and the author (p. 133) records that a gannet ringed there as a bird in down on August 25, 1944, was caught ten weeks later in a fishing net off Agadir, in Morocco. For thirty-four years a black-browed albatross, which won the name 'King of the Gannets' (p. 135), came to this solan colony at Mykineshólmur with the gannets. This bird of the southern hemisphere was shot on May 11, 1894, and the skin is preserved in the Natural History Museum in Copenhagen. On page 140 is given the record of a kittiwake ringed as a nestling on one of the Faeroe cliffs and recovered rather more than three months later off the coast of Newfoundland.

Leach's fork-tailed petrel arrives at its colony later in the evening, after spending the daylight hours at sea (p. 181), than the storm petrel. On page 183 is noted the habit of cats of taking storm petrels. I have known this happen also in the Hebrides.

I have been able to mention only a few of the good things in this book, which will be a delight to all who love Nature, and also to those who wish to learn something of the customs of a fine race of people, strong and self-reliant, and pro-British almost to a man during the darkest days of the Second World War.

SETON GORDON

NATURAL HISTORY OF BRITISH INSECTS

Insect Natural History

By Dr. A. D. Imms. (New Naturalist Series.) Pp. xviii + 317 + 72 plates. (London and Glasgow: Wm. Collins, Sons and Co., Ltd., 1947.) 16*s.* net.

As a medium for the study of natural history the insects have no equals. The number and variety of their species and the diversity of their habits are such that they afford unrivalled opportunities for the collector, the photographer or the mere observer. The appearance of a general introduction to the natural history of insects in Great Britain prompts some reflexions on the aims and purposes of the amateur entomologist. For British entomology has been built up in the past century and a half by the amateur. To-day there are so many professional openings in entomology that the boy with a consuming interest in insects will probably end by joining the profession. Yet the need for amateur entomology is greater than it ever was. For it is common knowledge that many students now graduate into entomology from the laboratory and the lecture room, with no real feeling for the insect as it exists in the field. It is a curious paradox that it is an ignorant use of insecticides of ever-increasing potency which is forcing the applied entomologist to reflect more and more closely upon the way in which insects live among themselves. It is the avowed purpose of the volumes in the New Naturalist Series to bridge the gap between the scientific worker and the lover of Nature; in the sphere of entomology it is the scientific worker who stands in need of education, at least as much as does the naturalist.

Dr. Imms is singularly well qualified to bridge this gap. He does not attempt a systematic survey of the subject but, in true insect fashion, he collects nectar where he finds it. Wings and flight, senses and behaviour, ordinary and extraordinary habits of feeding, gall formation, the curiosities of insect reproduction, means of protection, aquatic insects and social life—these are some of the subjects, chosen because the author finds them interesting; and it is remarkable how much of the cream of the subject he has taken off. Science is not much use unless it can be brought to the understanding of the ordinary man and incorporated into common knowledge; and it is in the integration of classification, morphology, physiology, ecology and anecdotal natural history that the author has been so successful. The reader will find plenty of anecdotes—often with a pleasant turn of phrase, and without the creaking which is apt to characterize the witticisms of some scientific authors. "If a housefly could keep a diary of its doings it would be a most sordid document" is effective by what it leaves unsaid.

A "Documentary Appendix" is added with the object of guiding the reader to specialist works. This serves to emphasize once more how lacking we are in systematic books on the British insects, so that it is almost impossible for the amateur to make much headway except with two or three of the most worked orders. It is unfortunate that this appendix contains almost no references to economic entomology apart from those on biological control.

No review would be complete without some reference to the illustrations—forty plates from coloured photographs and thirty-two in half-tone—which are an outstanding feature of this book. Not all are uniformly good, but most are excellent. The coloured 'close-up' of a Capsid bug about to plunge its stylets into a plant (Plate 37) is particularly successful. Some of the coloured illustrations have that disagreeable aniline quality—but the book should be read only by artificial light; then almost all are wholly delightful, and even Plate 5 of *Libellula depressa* is tolerable.

Some typographical errors there are, but not a great many. On Plate 18 the large white butterfly is called *Pieris rapæ*; in Plate 34*b* surely the yellow larva at the top is the prepupal instar of the gooseberry sawfly. As in the other volumes of this series, the editors state that they have done their best to see that the author has got his facts right, but that he alone is responsible for what he says about them. Is this statement really necessary?

V. B. WIGGLESWORTH

ALGEBRAIC GEOMETRY

Methods of Algebraic Geometry

By Prof. W. V. D. Hodge and Dr. D. Pedoe. Vol. 1. Book 1: Algebraic Preliminaries; Book 2: Projective Space. Pp. viii+440. (Cambridge: At the University Press, 1947.) 30*s*. net.

"THIS volume is the first part of a work designed to provide a convenient account of the foundations and methods of modern algebraic geometry." These words from the authors' preface explain the scope of the present volume and account for the selection of topics treated. It has become increasingly clear in recent years that a rigorous treatment of algebraic geometry must be based, to a much greater extent than the classical accounts of the subject, on algebraic principles. It is therefore no occasion for surprise that more than a third of the volume under discussion is purely algebraic. The first four chapters constitute, in fact, a clear and concise introduction to the theory of algebraic fields, polynomials and matrices (over a ground field which is not necessarily commutative). This account is in itself most valuable, since the modern point of view in algebra is not to be found in many English works, though several accounts have been published in the United States.

The next two chapters deal with the foundations of projective geometry, first on an algebraic and then on a purely synthetic basis. A comparison in detail of these two independent formulations of the theory is full of interest. It will be noticed, for example, that the synthetic treatment is much longer. This is due in part to the fact that it starts from abstract axioms, whereas the algebraic development presupposes a knowledge of fundamental algebraic results; but a second and most significant reason is that in the synthetic treatment it is necessary to consider in detail a rather large number of special cases (in themselves of a somewhat trivial nature) in order to assert the validity of general theorems. It is not always sufficiently realized that the apparent elegance and brevity of a synthetic proof of a geometrical theorem may conceal tacit assumptions as to the generality of the figure under discussion which logically demand examination. A novelty in the present treatment, which otherwise follows classical lines (though with unusual care in matters of detail), is that the assumption of Pappus' theorem is deferred until after the introduction of co-ordinates.

The remaining chapters deal with Grassmann co-ordinates (where one would welcome, if possible, the introduction of a more elegant notation), and with the general theory of collineations and correlations, and the reduction of their equations to canonical forms. The geometrical content of the book thus never leaves the domain of projective geometry; the more general birational theory will presumably appear in the second volume.

This treatise is likely to become a standard work. It is notable for its clarity of treatment and for the rigour of its demonstrations, and will repay careful study even in those parts which deal with matters generally considered familiar. The printing maintains the standard that we have come to expect from the Cambridge University Press.

J. A. TODD

DISTRIBUTION OF TIME IN BRITAIN

British Time

By Donald de Carle. Pp. 199+47 plates. (London: Crosby Lockwood and Son, Ltd., 1947.) 15*s*. net.

MR. D. de CARLE has assembled a great deal of interesting information regarding the standardization and distribution of time in Great Britain. The majority of people take for granted the accurate time available from such sources as the B.B.C. time signals, Big Ben and 'TIM'. After a brief opening chapter on various early forms of time-keepers, the author deals with the history and present constitution of the Royal Observatory, Greenwich; this chapter brings out the astonishing accuracy with which time is measured and distributed over the radio, and further emphasizes the fact that the pendulum clock is giving way to the quartz-crystal clock when the highest possible accuracy is required.

Reference is made to the facilities for testing watches and the issuing of 'Kew certificates', and in Appendix 2 details of the test and specimen performances of watches obtaining various numbers of marks are given.

Chapters 4 and 5 deal with the development of the clock and the clockmaking industry in Britain, the section on Big Ben serving to emphasize what a redoubtable machine it is, both from the point of view of size and accuracy of performance.

The section dealing with electric clocks contains much information, particularly regarding the development of the Shortt clock, but the description of the quartz clock is unfortunately rather poor.

The chapters on the need for time signals and their history, and the evolution of 'TIM' are of particular interest, and the great amount of development work needed to produce the latter excellent service is given due prominence.

Although the style and lay-out of the book might have been better, it contains a range of information which is not collected together in any other publication, and the book can therefore be recommended with confidence to anyone interested in the subject of time and timekeepers.

R. A. FELL

Astronomical Navigation Tables

(Air Publication 1618.) Vol. A: Latitudes 0°–4° North and South. Prepared by H.M. Nautical Almanac Office on behalf of the Air Ministry. Pp. 233. (London: H.M. Stationery Office, n.d.) 7*s.* 6*d.* net.

IN 1936 the Nautical Almanac Office undertook, by agreement with the Admiralty, the preparations of an "Air Almanac" and of "Astronomical Navigation Tables" for astronomical navigation in the air. The "Air Almanac" has always been on sale to the general public; but the "Tables" have been restricted to official use and are now for the first time being placed on general sale.

The complete set of tables comprises fifteen volumes, catering for all latitudes from 79° N. to 79° S. Fourteen of these cover belts of 5° of latitude both north and south of the equator; the fifteenth covers the ten degrees 70°–79°. The tables are designed to facilitate the calculation of the altitude and azimuth of an observed heavenly body. For each degree of latitude and for each degree of hour-angle, the altitude is given to the nearest minute of arc and the azimuth to the nearest degree for each of twenty-two selected bright stars, well distributed over the sky, within the range of altitudes between 10° and 80°, and also for each degree of declination from 28° S. to 28° N., which covers the range of declination for the sun, moon, and planets. The computed altitudes include the effect of refraction at a height of 5,000 ft., but a table of corrections for other heights, from sea-level, for surface navigation, to 40,000 ft., is given.

In order to avoid interpolation with three arguments, the tables are intended to be used with an *assumed* position, corresponding to tabulated values of latitude and of hour-angle. No provision is therefore made for interpolation other than for declination.

The tables are well designed and well printed, and their convenience in practice has been amply proved by their extensive use during and since the War by the Royal Air Force. Though intended primarily for air navigation, they are equally useful for surface navigation, subject to the limitations of accuracy inherent in the tabulations of altitudes to the nearest minute of arc. H. SPENCER JONES

Regions and Nations of the World

By Assoc. Prof. Earl E. Lackey and Asst. Prof. Esther S. Anderson. Reprint. Pp. xix+489. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1947.) 26*s.* net.

THE authors have here tried to choose what they think most useful for a course in world geography to be given in a year, or abbreviated into a semester, in an American college or university. It requires "few if any additional references or assigned reading to be provided by the instructor"; the reviewer would add here 'more's the pity'. The scheme for each region is (*a*) natural features, (*b*) cultural features leading on to urban centres, and sometimes on to a short appraisal of current problems or of prospects. The book has many illustrations and the photographs are often very telling; the maps are of poor quality. Cultural features are usually notes on commercial and political matters; they vary greatly in appositeness but are sometimes quite to the point, though the accounts of cities are so short as often to be trivial. The book has 100 pages given to the United States and 37 to the rest of North America, 60 to South America, about 140 to the whole of Eurasia, 38 to Africa and 30 to Australasia and Antarctica. The aim is to say something about every region and every country and every really big town, and to follow as uniform a plan as possible, all commendable in a certain measure as facilitating reference to a limited extent; but the book needs vitalizing.

Surely a course of this kind should aim at giving a vision of vital change going on everywhere, a vision that would tempt students who are interested to follow the subject for themselves thereafter. One judges from the text that the writers have not much knowledge of what Edinburgh or Zurich, to take two instances, mean in the human story; but it would be unprofitable to go on with hundreds of instances of missing the point. We must be thankful that geography is being increasingly recognized in the United States and hope that its exponents there may improve on this type of book; so many American books have such high quality already. H. J. F.

The Psychology of Ego-Involvements

Social Attitudes and Identifications. By Muzafer Sherif and Hadley Cantril. (Wiley Publications in Psychology.) Pp. viii+525. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1947.) 36*s.* net.

THE chief aim of this competent work is to show that the 'ego', or rather the 'ego-involved reaction', is an outcome of social forces impinging upon the individual throughout his life. The authors are deeply versed in the literature of experimental psychology, sociology and social anthropology, and by skilfully weaving together relevant results of research in these fields bring abundant evidence in support of their thesis.

Starting with an analysis of the theory of attitudes and making full use of the important concept of 'frame of reference', they trace the growth of the ego through infancy and childhood and its re-formation in adolescence. This is followed by a valuable treatment of the structural properties of diverse groups in which the participant 'egos' take their shape, and a study of ego pathology in conditions of stress, deprivation and group disintegration. Phenomena brought to light are further illustrated by reference to drama and fiction. Finally, there is a critique of the psychoanalytic theory of the ego, a critique which many readers will think too severe in its conclusions.

The book is a substantial contribution to social psychology. Its robust attention to concrete situations of social life gives it realism without loss of scientific value. As the authors rightly say, scientific objectivity is derived from the methods employed and not from the aloofness of the worker. JOHN COHEN

Bird Life in Cornwall

By B. H. Ryves. Pp. 256+16 plates. (London and Glasgow: Wm. Collins, Sons and Co., Ltd., 1948.) 10*s.* 6*d.* net.

LOCAL ornithologies to be of value must be precise, and they therefore tend to become lists; however, Lieut.-Colonel B. H. Ryves in his volume dealing with bird life in the most southerly counties of England has cleverly avoided this by dividing his book into two parts. The first includes an account of Cornwall and its bird haunts and has chapters on such outstanding Cornish birds as the chough, raven, peregrine, common buzzard and Montagu's harrier. In the second part we have a guide to the birds of Cornwall with notes on behaviour, etc. The whole is admirably illustrated with pen-and-ink sketches by R. A. Richardson, his pintails, showing a duck and drake floating on still water, being a particularly satisfying picture.

As we have said, the early part of the book is that devoted to general observations, and it affords much interesting reading; for example, the account in Chapter 3 of migration movements of sea-birds. The author describes how on March 22, 1932, a warm and sunny day, he watched from Gurnard's Head for five hours an immense stream of birds. "Guillemots and razorbills, the former predominating, kept passing at speed low over the sea in flocks of 100 to 200 birds . . . they were travelling when I came on the scene and still travelling when I was obliged to leave." Gannets, shearwaters and herring gulls also passed, and the author wonders "what was the meaning of this vast 'migrational' movement? The gannets and shearwaters were travelling away from their breeding stations off the Welsh coast." Two other especially interesting chapters are those on the chough—with particular reference to its decrease—and the Montagu's harrier, with its history of the vicissitudes of certain individuals.

Frances Pitt

The Spell of the Honey Bee

By W. Eric Kelsey. Second edition, revised. Pp. xi+274+49 plates. (London: Chapman and Hall, Ltd., 1947.) 18*s.* net.

THE first edition of this book appeared in 1945 and it was rapidly exhausted. This in itself is a tribute to its merits and that it has fulfilled a need. The author is to be congratulated on the publication of a second edition so soon afterwards and, in his revision, he has taken the opportunity of rewriting the chapter dealing with bee diseases. The book is one of the most attractive bee-keeping manuals we can recall. The essentials of the craft are explained with a freshness of style that is one of the book's special attractions. Also, its value is enhanced by the copious series of half-tone plates, some of which are of exceptional merit. The working drawings of hives and appliances are an additional feature that makes the text easy to follow. Written as a manual for beginners, and with the idea of producing efficient bee-keepers, nevertheless the more experienced will find much that is of interest within its pages. It is obviously outside the scope of the author to discuss the scientific aspects of the bee in any but very general terms and, although he may be a little weak on some parts in this field, the fault scarcely detracts from the merits of the book as a whole.

I Bought a Farm

By Roy Genders. Pp. 112 + 8 plates. (Worcester: Littlebury and Co., Ltd., n.d.) 10*s.* 6*d.* net.

WHEN an author buys a farm and sets about working it for profit, what more natural than that he should proceed to record the ups and downs of his first year's operations for publication. Mr. Genders, released from the R.A.F. after the War, purchased Holly Gate Farm. It was an upland Derbyshire holding of about 78 acres with an ancient but substantial homestead and buildings in a very poor state of repair. In any circumstances a new start in a farm is an anxious business, but the year 1946–47 was a nightmare for any farmer, experienced or otherwise, for one of the wettest harvests on record was followed by a very severe winter. In this book we follow the day-to-day struggle of the author and his two men to make good in the face of great difficulties. A few useful sidelines, such as mushroom growing and dog breeding, made a useful contribution to the enterprise. The story ends on a note of quiet optimism. The account is written in a conversational, almost gossipy style, and will commend itself to the general public rather than to the body of farmers, who will already be familiar with much of the technical information, and will also have experienced all the hazards, hitches and satisfactions there recorded.

Students' Handbook to Fertilizers and Soils

By L. T. Lowe. Edited by G. H. Purvis. (Published for the Monmouthshire Institute of Agriculture.) Pp. 84. (Worcester: Littlebury and Co., Ltd., 1947.) 7*s.* 6*d.* net.

THIS book aims at giving a simple account of the scientific principles of manuring and of soil science suitable for students at farm institutes. It is always difficult to write simple but accurate books in any science that are acceptable to research workers in that science. The difficulty is particularly great in agricultural science, both because the scientific principles of many practical techniques are not too well understood and also because of the great scarcity of clear accounts of the present-day views held by the research workers themselves. Thus lecturers in soil science and crop nutrition in farm institutes and agricultural colleges can justly complain that they are not well served by the research institutes of Britain, and this book unfortunately illustrates the truth of this complaint.

The book suffers in the first place from a brevity so extreme that the choice of topics mentioned appears to be arbitrary, and statements of apparent facts or theories often lack very necessary qualifications. It also, unfortunately, contains a certain number of false statements or obsolete theories. But there are many places in which it gives a reasonable account of some of our present ideas on fertilizer practice and soil science.

E. W. Russell

Poisons: their Isolation and Identification

By Frank Bamford. Second edition, revised by Dr. C. P. Stewart. Pp. viii + 304. (London: J. and A. Churchill, Ltd., 1947.) 21*s.*

THIS is a book which within a relatively small compass gives a vast amount of information. The distinguishing feature of this information is its usefulness. In too many books describing processes of scientific investigation, one finds that some vital detail of technique is not mentioned, and further research is required before the technique can be successfully used. This is not true of 'Bamford'. The details given are adequate for the working out of the processes described and they bear the marks of the author having used them.

The book, however, is not a mere catalogue of toxicological processes, and much information of general interest is given; a particularly good example of this is the short chapter on drugs of addiction.

There is no mention in the section on alcohols of the effect of the passage of time after death on the concentration of alcohol found in the blood. The book is fairly well up to date, although some of the more modern industrial poisons are missing. It is a little surprising to read that chloral has almost gone out of use in modern therapeutics. This is, however, rather outside the author's true scope within his scope this is a good book.

Edgar Rentoul

DIFFRACTION FROM THE IONOSPHERE AND THE FADING OF RADIO WAVES

By J. A. RATCLIFFE
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WHEN a wireless wave is received partly or wholly by way of the ionosphere, it is observed to fade. Much of this fading is due to interference effects between waves which have travelled by different paths. Such waves may include the ground wave, singly or multiply reflected ionospheric waves, waves reflected from different ionospheric regions, or the two magneto-ionic components produced by the presence of the earth's magnetic field. It is, however, possible to isolate and observe only one downcoming wave from the ionosphere, for example, by the use of a pulse sender and a circularly polarized receiving aerial or by the use of a special aerial to suppress the ground wave under conditions when the absorption of the downcoming wave is large enough to make second reflexions unimportant. When only one downcoming wave is observed in this way, it is still found to fade at a speed which varies from time to time. Although few detailed observations of this kind of fading have been reported, workers in the subject will probably accept the general statement that the speed of fading is roughly proportional to the frequency of the wave and inversely proportional to the distance of the transmitter[1].

It is also known that the fading of a single ionospheric wave received at vertical incidence shows some dissimilarity at two points separated by about one wave-length, and from this fact it may be deduced that the wave is returned by a process of irregular diffractive reflexion from an ionospheric region which is considerably inhomogeneous in the horizontal plane[2,3]. It therefore appears more correct to think of the single wave returned from the ionosphere not as one sharply reflected from a smooth mirror, but as a cone of rays returned to the receiver from a diffuse scattering region in the ionosphere, much as light from a street lamp on a bridge might be reflected from an irregularly rippled stream to an observer standing near by. The consequences of this supposition are being worked out by considering the diffractive reflexion from a completely rough surface, and it appears that useful information may be obtained about the 'degrees of roughness' of the ionosphere in this way. It also appears that the amplitudes of waves successively reflected between ground and ionosphere may not be in the ratio expected for 'mirror-like' reflexions, and this fact may have important bearings on the deduction of reflexion coefficients by the usual methods. It is not, however, the main purpose of this article to develop more fully the ideas of the ionosphere as a diffractive reflector, but to suggest that if the roughness of the ionosphere is supposed to vary in a random manner, then the salient phenomena of the fading of a single wave can be explained. The possible causes of the roughness and variability will not be discussed.

To represent a varying rough ionosphere in a simple manner, we assume that there exist several scattering 'centres' distributed approximately in a horizontal plane and that each scatters the same power from the incident wave. The term 'scattering centre' is here used in the sense common in the theory of diffraction, and no attempt is made to define it more precisely. The 'centres' make up the irregularities which form the roughnesses discussed above, and although related to the scattering centres of Eckersley are not necessarily the same. It is assumed that the 'centres' are in continual random motion in such a way that the velocities v in the line of sight are distributed according to a Gaussian law; so that the number $P(v).dv$ of centres with velocity between v and $v + dv$ is given by

$$P(v) . dv = A \exp(-v^2/2v_0^2)dv, \qquad (1)$$

where v_0 is the root mean square velocity of a 'centre'. We consider the case of a receiver placed close to a sender emitting pulses of radio frequency f_0 as in the usual method of exploring the ionosphere at vertical incidence. The reflected wave suffers a Doppler shift of frequency after scattering from each of the 'centres', so that its frequency on returning to the ground is given by

$$f = f_0(1 + 2v/c). \qquad (2)$$

The phases of the contributions from different 'centres' may be assumed to be randomly distributed, since the 'centres' are at random distances. Powers, therefore, add at the ground, and the resultant electromotive force consists of components of different frequency, the power $W(f).df$ in each frequency-range being obtained by combining equations (1) and (2) to give

$$W(f)\, df = B \exp\{-c^2(f - f_0)^2/8f_0^2v_0^2\}\, df. \qquad (3)$$

For a reason which will be apparent shortly, we may also write this expression as

$$W(f) . df = \frac{\psi}{\sigma\sqrt{2\pi}} \exp\{-(f - f_0)^2/2\sigma^2\}\, df, \qquad (3a)$$

$$\left.\begin{array}{l}\text{where } \sigma = 2f_0v_0/c = 2v_0/\lambda, \ \lambda \text{ being the wave-length of the wave} \\ \text{and } \psi = \int_0^\infty W(f) . df = \text{the total power in the wave.}\end{array}\right\} \qquad (3b)$$

The fading of the wave is now seen to result from the beating between the component waves of different frequency represented in equations (3). But a series of E.M.F.s with random phases and with powers as given by (3) is *precisely what would result if random noise were passed through a filter the band-pass characteristic of which for power was given by* (3).

Now Fürth and MacDonald[4] have made a detailed analysis of the noise emerging from a filter with a power-pass-characteristic given by equation (3a), which is their equation (12). They have shown first that the amplitude R of the quasi-sinusoidal output E.M.F. is distributed according to a Rayleigh law, so that the probability $p(R).dR$ of finding an amplitude between R and $R + dR$ is independent of the filter and is given by

$$p(R) = (R/\psi) \exp(-R^2/2\psi), \qquad (4)$$

the mean amplitude $\overline{R}$ being given by

$$\overline{R} = \sqrt{\pi\psi/2}. \qquad (5)$$

They also show that the temporal rate of change of the amplitude depends on the characteristics of the filter in the following way. If the amplitude of the output E.M.F. is plotted against time, and if the time axis is divided up into *short* elements τ, and v_τ represents the change of amplitude which occurs during one of these intervals, then the probability

$P(v_\tau)dv_\tau$ of observing a change between v_τ and $(v_\tau + dv_\tau)$ in any one interval is Gaussian and is related to the pass-characteristic of the filter by their equation (19), which states that

$$P(v_\tau).dv_\tau = c \exp \{-(v_\tau/2\pi\sigma\tau \sqrt{2\psi})^2\}.dv_\tau. \quad (6)$$

On our present theory it follows that the fading E.M.F. received from the ionosphere will have these same characteristics, so that it should be described by expressions (4) and (6). My colleague, Mr. S. K. Mitra, has analysed fading curves obtained by observing a single pulse at 4 Mc./s. reflected from Region *F* and received on a circularly polarized aerial and has shown that the results agree well with these equations. This agreement encourages us to believe that the explanation is correct, and to use it to deduce the R.M.S. random velocities of the scattering centres in the following way.

A comparison of the experimental results with equation (6) yields the value of the quantity $\sigma\sqrt{2\psi}$, and since equation (5) relates ψ to the mean amplitude of the received E.M.F. we can determine σ, and hence find v_0 from (3*b*). A typical fading record, analysed in this way, has yielded the value 5 m./sec. for the R.M.S. velocity of the scattering 'centres'.

A little further calculation yields a useful expression for the 'speed of fading'. Fürth and MacDonald[4] define a quantity ε given by

$$\varepsilon = \operatorname*{Lim}_{\tau\to 0} (\overline{|v_\tau|}/\tau) = \sqrt{2\pi\psi}.\sigma = 2\bar{R}\sigma = 4\bar{R} f_0 v_0/c,$$

where $\bar{R}$ is the average E.M.F. In our case we may use the quantity $\varepsilon/\bar{R}$ as a logical measure of the speed of fading, and may then state the position in words as follows.

Let a fading curve in which the amplitude of the received E.M.F. is plotted as a function of time be divided up into short elements of time τ, and let v_τ represent the change in amplitude during the time τ, and $\bar{R}$ the mean amplitude; then the quantity $\overline{|v_\tau|}/\tau\bar{R}$ tends to a limit as τ tends to zero, and is here called the 'speed of fading', *S*. It is related to the velocities of the scattering centres by the expression

$$S = \overline{|v_\tau|}/\tau\bar{R} = 4f_0v_0/c = 4v_0/\lambda. \quad (7)$$

It is at once apparent that the speed of fading is proportional to the frequency of the radio wave, in agreement with the facts mentioned at the start of this article.

If we had to do with only two scattering centres, one of which remained stationary and the other moved in the line of sight with velocity v_0, then we should record a complete cycle of fading in a time t such that $1/t = 2v_0/\lambda$. Equation (7) shows that the 'speed of fading' (*S*) in the case of several centres moving at random yields a quantity of the same order of magnitude.

In some experiments being made in Cambridge, the phase variations in a single downcoming wave are being studied, and it is of interest to consider what may be deduced from them. These phase variations are likely to be of importance in direction-finding and in radio navigational aids. If the downcoming wave is composed of contributions from several moving scattering 'centres', the phase φ will vary in a random manner, and a record of φ plotted against time may be analysed by dividing it up into short equal intervals τ, in which φ changes by $\Delta\varphi$, and evaluating the quantity $\operatorname*{Lim}_{\tau\to 0} \overline{|\Delta\varphi|}/\tau$, which may be called the 'average rate of change of phase'. We should expect this quantity to be simply related to the corresponding rate of change of phase $(2\pi.2v_0/\lambda)$ produced by reflexion from a single 'centre' moving with the velocity v_0 in the line of sight, and I am indebted to Dr. D. K. C. MacDonald for a proof that, in fact, the two quantities are equal. Dr. MacDonald has also shown how the probability of obtaining a value of $\Delta\varphi$ is related to $\Delta\varphi$ and has provided a theoretical expression with which measurements can be compared.

I have been able to examine records of the phase-variations of a single downcoming wave from Region *E* made on 2 Mc./s. by Mr. J. W. Findlay and on 100 kc./s. by Mr. K. Weekes, both working in Cambridge. The method used by Mr. J. W. Findlay has previously been described and a sample record illustrated[5]; the only records amenable to analysis are those of the simpler type illustrated in his Fig. 3. Mr. Weekes uses a method which has not yet been described. For both these frequencies I find that the probability distribution of the quantity $\Delta\varphi$ agrees fairly well with the expression of MacDonald. For the frequency of 2 Mc./s., the R.M.S. velocity deduced for the 'centres' is 0·5 m./sec. and for 100 kc./s. it is 1·0 m./sec. These orders of magnitude are consistent with that deduced from Mr. Mitra's analysis of the amplitude of fading on 4 Mc./s.

I have also been able to examine some measurements of the phase and amplitude of the downcoming wave observed at nearly vertical incidence by Mr. R. N. Bracewell on 30 kc./s. and 16 kc./s. These measurements have been made by an extension of the technique described by Best, Ratcliffe and Wilkes[6] and Budden, Ratcliffe and Wilkes[7]. On these frequencies the refined techniques now in use frequently show the occurrence of a relatively rapid variation of phase and amplitude superimposed on a slower variation. If the results are first smoothed so as to remove the more rapid variation (phase changing at the rate of about 2π in 5 min.), it is possible to analyse both the phase and amplitude records in the manner previously explained. Although the smoothed fading is then so slow (phase at the rate of about 2π in $1\frac{1}{2}$ hr.) that the probability distribution cannot be checked in any detail, there is no obvious disagreement with the theory, and the mean values for the speed of amplitude and phase fading both lead to the same value, approximately 1·0 m./sec. for v_0. There appears to be no counterpart, on the higher frequencies, to the more rapid fading observed on these very low frequencies.

We have seen that observations at nearly vertical incidence on frequencies from 4 Mc./s. to 16 kc./s. yield results of the same order for v_0, provided we smooth out the more rapid fading on the very long waves. This agreement is indirect proof of the statement made at the start of this article that the rate of fading is proportional to the wave-frequency. It is next of interest to consider the phenomena associated with oblique transmission through the ionosphere.

By considering how a movement of a scattering centre affects the length of path of waves scattered from it at oblique incidence, it can be shown that the speed of fading should be roughly inversely proportional to the distance of transmission, provided that this distance is greater than the height of the reflecting region. Mr. R. W. McNicol has kindly made an analysis for me of some fading curves of distant broadcasting stations, provided through the courtesy of the B.B.C., and has shown that they can be explained in terms of scattering centres moving with random velocities of the same order as those deduced from the experiments made with vertically incident waves.

Up to this stage in the discussion we have assumed that the Doppler shift in the component waves occurs during backward scattering from moving 'centres' *situated in the reflecting region.* If, however, a wave, reflected from a given region (1), passes through an irregular region (2) below, then it will suffer diffraction at region (2), and if the scattering elements in region (2) are in motion, the diffraction pattern at the ground will vary with time, and an observer at a fixed point will notice that the wave 'fades'. The matter is complicated because the wave traverses the diffracting region twice, once on the upwards and once on the downwards journey; but the nature of this fading can be deduced, to a first approximation, by considering the Doppler shift due to the forward scattering from the scattering centres in region (2), and the results are then somewhat dependent on the assumptions which are made about the motions of these centres. The general trend of the calculations is the same as before, but the Doppler shifts are smaller for the same velocities.

Useful information should be obtainable by making simultaneous observations on the fading of single echoes from Regions E and F. If the fading of echoes from both regions were due to the movements of reflecting clouds in the appropriate region, then we should expect the application of the analysis given in detail in this article to apply to each echo separately, and to give an R.M.S. velocity v_0 which would probably not be the same for both. If, however, the fading of both echoes were due to inhomogeneities in an absorbing region below both reflecting regions, then the fading of both echoes should be explicable in terms of the same velocities in the absorbing region, provided we used the type of analysis applicable to transmission ***through*** a diffracting region. If the fading of the echo from Region E were due to backwards scattering from moving elements of that region, whereas the fading of the echo from Region F were due to the fact that it had passed through the irregular Region E, then we should have to use different types of calculation for the two echoes in order to get concordant results for the R.M.S. velocity v_0. These possibilities are being tested.

Although the theory outlined in this article is only meant to be a first approximation to the truth, it is nevertheless thought to contain the essence of the explanation of the fading of a single echo. Obvious extensions of the theory include the consideration of:

(*a*) A steady component of E.M.F. reflected from a constant and uniform part of the ionosphere in addition to that returned from the scattering centres. This will give rise to effects similar to those obtained when a steady E.M.F. is added to the output of a Gaussian filter-passing noise, and the analysis will follow that of Fürth and MacDonald for this case.

(*b*) 'Centres' which do not all scatter equal powers, and 'centres' the scattering effect of which varies with time.

(*c*) Velocities of the centres which are not distributed in a Gaussian manner.

(*d*) Different velocities in the horizontal and vertical directions.

(*e*) The possibility that, if the 'centres' are embedded in a region where the refractive index is considerably less than unity, the Doppler effect will be less than that indicated, so that the value of v_0 will be greater than that calculated here.

In conclusion, it may perhaps be pointed out that there are obvious analogies between the reflexion of a radio wave from randomly moving scattering 'centres' and the radiation of monochromatic light from a series of molecules moving with random heat motions. The broadening of the spectral line in the optical case is analogous to the spread of frequencies in the radio case, and if the light could be observed sufficiently rapidly it would be found to be fading, just as the radio E.M.F. fades.

I am indebted to my colleagues mentioned above, who have kindly put their observations at my disposal. Their researches are supported by a grant from the Department of Scientific and Industrial Research. I am also indebted to Dr. MacDonald for help with the analysis of phase.

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SOME COMPONENTS OF THE LYTIC SYSTEM OF GRAM-POSITIVE MICRO-ORGANISMS

By PROF. M. STACEY and DR. M. WEBB
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FOLLOWING certain pioneer work and suggestions by our former colleague, Dr. H. Henry, it was apparent that much information regarding the structure of Gram-positive bacteria and their behaviour when acted upon by antibiotics could be obtained from a study of bacterial autolysis. The few detailed studies of autolysis which have previously been made have been mainly confined to the pneumococcus group. Goebel and Avery[1] showed that the autolytic disintegration of pneumococci was accompanied by proteolysis resulting in an increase in both amino-nitrogen and non-coagulable nitrogen, and by lipolysis liberating ether-soluble fatty acids. A non-specific cell-free autolytic enzyme system acted upon heat-killed pneumococci to give results comparable with those from spontaneous autolysis and also brought about the partial lysis of suspensions of heat-killed *Streptococcus viridans*[2].

In confirmation, Dubos[3] further made the significant observation that before lysis of the cells occurred the cocci first became Gram-negative, and this change in the Gram staining reaction was not necessarily associated with complete lysis of cells. It was possible, moreover, to effect this change in the Gram-staining reaction of heat-killed, Gram-positive penumococci by the action both of pancreatic ribonucleinase[4] and a ribonuclease-like 'tissue enzyme' isolated from rabbit leucocytes[5] (cf. Bartholomew and Umbreit[6]).

In our hands, these and other enzymes, for example, from the lower fungi, have been found to render Gram-negative a range of heat-killed Gram-positive micro-organisms. The change in the Gram-staining reaction appears to be brought about only by enzymes of the ribonucleinase type, that is, those which hydrolyse ribonucleic acid to the four mononucleotides[7]. We have found by way of contrast that preparations of intestinal phosphatase and of a phosphatase from dog fæces[8], although able to hydrolyse free yeast ribonucleic acid with the liberation of inorganic phosphate, had no action upon heat-killed Gram-positive cells.

Extension of our investigations to bacterial autolysis has shown that it is possible to divide the cellular disintegration of most Gram-positives into two separate and distinct stages, namely, (*a*) the change from Gram-positive to Gram-negative, and (*b*) the subsequent lysis of the Gram-negative cytoskeletons. We have so far recognized four distinct enzyme systems involved in the cellular disintegration. The extent to which the two stages occur in suspensions of autolysing Gram-positive cells depends sharply upon the *p*H and upon the oxidation-reduction potential of the system. For bacterial autolysis, there appears to be an optimum *p*H for each species which varies from *p*H 5 for certain sarcinæ to *p*H 8 for clostridia and some staphylococci. Our colleague Dr. Henry made the striking observation that, under reducing conditions, only the first stage of autolysis occurs, and this results in the formation of Gram-negative cytoskeletons which do not undergo further digestion at any *p*H less than 7. By carrying out autolysis in the presence of suitable reducing agents, such as hydrogen sulphide or thioglycollic acid, it was found possible to obtain in solution and free from the enzymes concerned with complete cellular disintegration, the enzyme system responsible for the initial stage of autolysis. Detailed studies of the properties of 'initial stage' enzymes from both *Cl. welchii* and *Staph. citreus* have shown that the two are closely similar. They have in common the property of hydrolysing free yeast ribonucleic acid but not deoxyribonucleic acid, while they differ in several respects from the ribonucleinase of animal tissues[4]. Thus they have *p*H optima at 7–8, are inactive at *p*H 4·0, are activated by reducing agents and inhibited under oxidizing conditions. Irreversible loss in activity occurs when the enzyme solutions are heated at 80° for 30 min., whereas at 60° any inactivation is dependent upon the *p*H and the time of heating, the enzymes being most stable at *p*H 8.

Although the enzymes from *Cl. welchii* and *Staph. citreus* both have the property of hydrolysing free ribonucleic acid, they are species specific, and indeed to some extent strain specific, in their action on heat-killed Gram-positive cells. Thus, the enzyme from *Cl. welchii* readily converted heat-killed Gram-positive *Cl. welchii* to Gram-negative cytoskeletons, but had no action on heat-killed Gram-positive *Staph. citreus*, *Staph. aureus* or *Lactobacillus helveticus*. Similarly, the enzyme from *Staph. citreus* exhibited no action on the Gram complex of heat-killed Gram-positive *Cl. welchii* or even of *Staph. aureus*, but was active against a rough variant isolated from an aged culture of *Staph. aureus*. As the smooth–rough transformation is known to involve the loss of the ability to synthesize certain bacterial polysaccharides, the latter observation suggested that the specificity of these bacterial enzymes was in some way connected with the specificity of the polysaccharides of the cell.

Recent studies on the action of lysozyme[9] have shown that ribonucleic acid and the specific polysaccharides of Gram-positives are presumably in combination at the cell surface. When heat-killed Gram-positive cells are incubated with lysozyme, certain carbohydrate linkages are disrupted, the Gram staining reaction becomes negative and undegraded ribonucleic acid and polysaccharides are released into solution.

Further, specific polysaccharides of staphylococci and of *Cl. welchii*, isolated by procedures which did not destroy cellular structure, also were found to be hydrolysed to a small but definite extent by the action of lysozyme.

Since these same polysaccharides were not acted upon by the initial stage bacterial nucleinases, the latter appeared to be essentially free from lysozyme. However, it was shown that, during the action of these enzymes in the autoconversion of Gram-positives to the Gram-negative cytoskeletons, a small percentage of reducing groups was released and specific polysaccharides were liberated in an apparently undegraded state into solution (cf. a similar observation by Dubos[10] during pneumococcus autolysis). We conclude that the initial stage in the autolysis of Gram-positives involves an enzyme, highly specific in its action, which breaks the relatively labile linkage joining the specific polysaccharide and the ribonucleic acid. Such enzymic activity is probably possessed by most preparations of animal ribonucleinases, and renders the Gram ribonucleoproteins[11] of the cells susceptible to the subsequent action of ribonucleinase. The latter breaks down the ribonucleic acid component to the mononucleotide stage, but does not disrupt the Gram-negative cytoskeleton.

All procedures which were found to inhibit the change in the staining reaction of Gram-positives to Gram-negatives also inhibited the ribonucleinase activity of the enzyme solution, and the variation in the activity of different enzyme preparations against killed cells was accompanied by a parallel variation in ribonucleinase activity. However, the fact that ribonucleic acid removed from one Gram-positive organism by extraction with sodium cholate may be replated on to the reduced Gram-negative cytoskeletons of a second extracted Gram-positive cell[11] would suggest that the bacterial ribonucleic acids themselves do not show any fundamental structural differences. This may account for the less specific nature of ribonucleinases, and suggests that the marked degree of specificity shown by the bacterial enzymes responsible for the conversion of Gram-positives to Gram-negatives is due to a 'polysaccharide-releasing' enzyme.

When the autolysis is rapid and less carefully controlled[12], the linkage between the nucleic acid and protein of the cytoskeleton may not be broken, and a certain proportion of the Gram-positive ribonucleoprotein is released into solution[12], so that the linkage between the nucleic acid and the protein, probably involving —S—S— linkage[11], is essentially firmer under certain conditions.

When a suspension of suitably prepared Gram-negative cytoskeletons is adjusted to *p*H 8, complete lysis rapidly follows. We have succeeded in isolating closely similar lytic enzymes from the cytoskeletons of *Staph. albus* and *Staph. citreus*. From both, preparations of two proteolytic enzymes were isolated, one of which hydrolyses casein but not peptone, and a second which hydrolyses peptone but not casein.

It was shown that the initial disintegration of the cytoskeletons is due to the action of the casein-hydrolysing enzyme. The protein fragments which result from this cellular disintegration appear to be further hydrolysed by the action of the peptone-hydrolysing enzyme.

In contrast to the enzymes responsible for the first stage (*a*) of bacterial autolysis, these proteolytic enzymes are not specific in their action and readily dissolved the Gram-negative cytoskeletons of all Gram-positives examined and also heat-killed true Gram-negative bacteria. They had no action on heat-killed Gram-positive cells, and it was concluded that these proteolytic enzymes do not play any part in autolysis until the cells have become Gram-negative.

In extension of these studies[13], we have shown that some *Actinomyces* cultures under certain conditions possess a system composed of a lipoidal bactericidal substance, a ribonucleinase and proteolytic enzymes. We have obtained evidence that such a system is also present in a culture filtrate of *Pseudomonas pyocyanæ* and in certain moulds which are antagonistic to bacterial growth. It would appear, therefore, that such a system may be of fundamental importance in the general phenomenon of bacteriolysis and may also have some bearing on the nature of phagocytosis. In the latter case, it will be recalled that leucocytes are known to contain an enzyme which hydrolyses ribonucleic acid[5] as well as proteolytic and other enzymes.

The precise role of lipases[1] and deoxyribonucleinases[14], said to be present also in Gram-positives, is under investigation.

We are grateful to Dr. H. Henry and Dr. A. S. Jones for considerable help and to the Medical Research Council for a grant.

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SOIL CONSERVATION

THE Food and Agriculture Organisation of the United Nations Organisation has recently published a beautifully produced booklet entitled "Soil Conservation—an International Study" (Washington, D.C.). It comprises 190 pages, of which about half are occupied by pictures. Thus the problems of world soil conservation are covered in about a hundred pages of text. The idea behind the publication appears to be to appeal to politicians, administrators and publicists without whose co-operation the urgent need for soil conservation may be overlooked until too late. These will get the impression that soil conservation is an American invention. It is not an entirely false impression, but there are countries—for example, Japan and Java, and, for that matter, Great Britain and others—in which soil conservation is so highly perfected that the 'problem' of soil conservation scarcely exists, and the achievements of these countries in adapting their methods of land utilization to the environment have consequently been overlooked. The authors of the booklet admit that "much attention has been given to China and the United States of America"; but it would be more accurate to say that the United States gets 75 per cent of the space, China 10 per cent, and the rest of the world 15 per cent. It is worth quoting all that this leading international agricultural authority has to say on physical losses from the mismanagement of farm lands in the world outside the United States, China and Latin America. Under the heading "Other Countries", it is stated: "All over the world, wherever man has cultivated sloping land, there has been soil erosion in some degree. In the Mediterranean region of Europe, in Asia, in North Africa, in tropical Africa and South Africa, and in India its results have been described, but little measurement has been made of its extent or severity." One of the results in India that "have been described" is far more human misery than soil erosion has caused in the whole of the United States. Australia and New Zealand are other countries that appear to have been overlooked.

There is some justification for this one-sided approach. Modern methods of soil conservation used all over the world and the principles of planning land utilization to suit the land have nearly all been developed in the United States, which are in advance of most other countries not only in the application of mechanical measures and in the adaptation of land utilization to soil conservation, but also in appreciation of the social and economic consequences of the adoption of soil conservation. But the achievements of soil conservation in the United States tend to blind people there to the lesser, but certainly not negligible, achievements of countries which have not the money, the men or the means to accomplish what the United States have done. The book leaves the impression that the authors have used the material immediately available in Washington, but have not troubled to look further afield. Something better is expected of an international study with the imprint of the Food and Agriculture Organisation.

The fact that about the only reference to soil conservation in the British Empire is the statement that British settlers have given much attention to pasture development suggests that there were not many representatives of Empire agriculture available in Washington while the book was being prepared. The countries of the British Empire have less to show in the conservation 'shop window' than the United States, but they have a lot in the 'shop' itself. The forest and agricultural departments of India did a magnificent piece of work in face of tremendous difficulties in checking the devastating erosion in the foothills of the Himalayas and elsewhere, much but not all of which was of recent origin. India has a problem of peculiar difficulty—over-population. This has led to a growing recognition of the fact that the welfare of the land is a communal rather than an individual responsibility, and to communal schemes of integrated soil conservation. The successful adaptation of the *taungya* system, to which the Food and Agriculture Organisation book only refers in passing, to purposes of soil conservation had already reached a high degree of development some decades ago. The Indian Forest Service has a reputation second to none for applying soil-conservation measures.

Australia, New Zealand and South Africa have learnt much in recent years from the United States, and with varying success have adapted American principles of soil conservation to their particular circumstances. The mechanics of soil conservation—that is, the prevention of water and soil from running downhill—are essentially the same everywhere; but environmental and social conditions in different regions require that soil-conservation measures should be integrated in different patterns. The art and science of soil conservation consist in building up a pattern of land use that will fit the physical, economic and social environment. All three Dominions have adopted the idea of the American soil-conservation district as the social unit for soil-conservation planning, but in different forms. It is still too early to say with how much success their plans will ultimately be crowned, but these embryonic experiments in applied human ecology deserve most careful attention.

In the British Colonial territories, too, the problems of soil conservation peculiar to tropical conditions are being tackled with increasing vigour and imagination. Whereas until recently most territories relied mainly on mechanical methods of erosion control, there is to-day a general awareness that these are only a means to an end, and that soil conservation must be integrated into systems of husbandry that will enhance the fertility of the soil. A few years ago the goal of many Colonial agricultural policies was at best to maintain soil fertility. Now it is to increase fertility; and with increased fertility should come increased stability, both of the soil and of society. This latter goal is still far from attainment; but those who control British Colonial policy seem to be gradually awakening to the importance of fundamental scientific studies for the conservation of the tropical environment. The work of W. S. Martin, who showed that grass fallows could have a dramatic effect on the restoration of soil fertility, the improvement of soil structure and resistance to erosion, promises to revolutionize the basis of arable agriculture in East Africa. Attention is also being paid to methods for improving pastures and controlling grazing, and to the proper role of fire in tropical agriculture. Many of these problems require expert knowledge of the structure of native societies for their solution.

To be effective, conservation measures in the tropics, as elsewhere, have to be applied on a regional scale, which involves co-operative or communal action, and may involve drastic modifications in land utilization. One of the great difficulties in the Colonies has been to secure co-ordinated action throughout a region. Responsibility for the welfare of the land is divided among many authorities whose interests do not always coincide. There is, indeed, need for conservation education and propaganda not only among native and European farmers, but also at high administrative levels. Native peoples, in Africa at any rate, often have a tradition of communal land ownership that should facilitate the enforcement of legislation designed to secure effective co-operative action in the control of soil erosion.

Several British Colonies and Protectorates have already enacted legislation to enforce soil-conservation measures or to regulate land use and conditions of land tenure for the purpose of conserving the soil. The trend of recent legislation has been towards the setting-up of regional authorities on the pattern of the American soil-conservation districts. Indeed, the invention of the soil-conservation district is probably America's greatest contribution to the promotion of soil conservation throughout the world. The authors of the Food and Agriculture Organisation booklet, with unnecessary modesty, make little reference to it; though they do state the astonishing fact that within the last ten years more than 1,000,000,000 acres—more than half the total land area of the United States—have been brought under the control of soil-conservation districts.

G. V. Jacks

THE COLONIAL MICROBIOLOGICAL RESEARCH INSTITUTE, PORT OF SPAIN, TRINIDAD, B.W.I.

IN 1945 Sir Robert Robinson and Prof. J. L. Simonsen, acting on behalf of the Colonial Products Research Council, paid a visit to the West Indies to acquaint themselves with the tasks in which scientific research could assist these and other tropical territories of the Commonwealth. From the observations they made in the Colonies which they visited, they concluded that almost every branch of science could be called upon to take a share in raising the prosperity of these lands; but that a special claim could be made for microbiology, of which only the most urgent medical aspects had been receiving attention in the past.

The Colonial Office accepted their conclusions and made funds available for the foundation of a Colonial Microbiological Research Centre to be situated within the tropics.

Port of Spain, Trinidad, was decided on as a suitable location. It was approved that the centre should devote its energies to fundamental research in microbiology; to the application of the results of its investigations; and to assisting agricultural and other industries in improving their products. Further, it was approved that the new Institute should form a centre for postgraduate training in microbiology. Afterwards, it was decided that a branch of the new centre should devote itself to the maintenance of a collection of micro-organisms which could be made freely available to interested institutes and to research workers in tropical and temperate climates.

To meet the needs of the new centre a building was designed, which, in addition to a library, comprises six laboratories, three for microbiological and one for biochemical research. One laboratory is reserved for the type culture collection, and one for the preparation of culture media.

A special room is provided for the cleaning and sterilization of glassware. Adjoining, and communicating with, the biochemical laboratory is a balance room; another room is provided for photomicrographic work, in which an electron microscope may eventually be set up, should this prove desirable. For the cultivation of micro-organisms requiring temperature of 18° C. and below for maximum growth, a special room has been provided, which is maintained constantly at this temperature. In addition, the building houses three offices, a cafeteria, a first-aid room and a store-room.

The whole building is air-conditioned and will be maintained at a temperature of 25·5° C. (78° F.) and a relative humidity of 60 per cent. The air-conditioning plant is housed in a penthouse on the roof of the one-storied laboratory building.

Since some of the investigations which the new centre is expected to undertake may eventually be adopted by industry, it was felt to be important to incorporate a pilot plant in the design of the institute. The pilot plant, when completed, will house, in addition to a complete fermentation plant of 400 gallons capacity with a separate distillation unit, a boiler house, a gas plant, an air compressor unit and a machine shop. From the pilot plant, gas, steam and compressed air will be supplied to the various laboratories, through underground pipe systems. All equipment for the pilot and air-conditioning plants are of British design and manufacture.

In view of the acute housing shortage throughout the West Indies and in Port of Spain in particular, it was agreed that housing facilities should be provided for the scientific staff within the grounds of the Institute. To this end a block of four flats has been erected within the six acres of grounds belonging to the Institute. A bungalow for the engineer has also been erected there.

The construction of the various buildings was commenced early in 1947 and has by now progressed so far that the Institute is to be opened officially on July 5, when Lord Hankey, chairman of the Colonial Products Research Council, has consented to perform the ceremony in person.

Invitations to attend the ceremony have been sent to Governments of the various Colonies, to Governments with Colonial possessions in the tropics and to the Governments of the neighbouring Central and South American States.

It is hoped to make the opening an occasion for informal discussions, among the delegates, of microbiological problems, particularly such problems as are met with under tropical conditions.

OBITUARIES

Prof. W. T. David

THE sudden death on May 22 of Prof. W. T. David has removed from the University of Leeds a man of real distinction with a vivid personality. For twenty-six years he was professor of engineering and administrative head of the Engineering Departments.

David was born in Laugharne in 1886 and was educated at St. David's County School. After a brilliant career at University College, Cardiff, he went to Trinity College, Cambridge, where he specialized in a study of infra-red radiation from flame gases and related combustion phenomena under the inspiration of the late Prof. B. Hopkinson. This field of research ultimately became his abiding interest. In 1912 he was appointed H.M. Inspector of Schools on the technological side; during the First World War he became inspector of gun ammunition with headquarters at Woolwich Arsenal and later director of dilution of labour at the Ministry of Munitions. In 1920 he was appointed to the chair of engineering at University College, Cardiff, and in 1922 he succeeded the late Prof. John Goodman in the chair of engineering at Leeds.

David was no narrow scholar, and was a strong advocate of education in the true university sense. He was a man of high integrity and sound judgment, and his brilliance, kindness and wisdom endeared him both to colleagues and students. He freely gave to all students and encouraged them to high endeavour by his inspiring teaching and the impact of his personality. In his lectures he would stress the importance of grasping the fundamental principles of engineering science, revealing the basic concepts in brilliant flashes, and would carefully lead the student in some branch of the subject on to the very frontiers of knowledge. David frequently likened this method of lecturing to students to taking them to the top of Mount Pisgah to view 'the promised land', so that with few words he would excite and fire the imagination of the students and make a lasting impression upon their minds.

In the field of research David directed his efforts mainly towards the problems of combustion phenomena and the related problems of internal combustion engines. At Cambridge he took special interest in heat loss from gaseous explosions, and he became intrigued with the problem of 'missing-pressure' in internal-combustion engines. This resulted in a comprehensive study of explosions of inflammable gaseous mixtures at a time when the lack of reliable thermal data handicapped his investigations. His intuition, however, led him to believe that flame gases were not really normal hot gases but possessed energy in excess of that of normal gases. The development of quantum mechanics and afterwards the provision of thermal data have made it possible to confirm his early ideas concerning flame gases. No one was more devoted to his subject or to his students.

Outside the University of Leeds, David was known in engineering circles in Yorkshire and elsewhere; was a member of the Institutions of Civil and of Mechanical Engineers, and was chairman of the Yorkshire Association of the Institution of Civil Engineers for the session 1928–29.

David was a man whose views were highly valued in any assembly and his contributions to discussion, often brief and pungent, were commonly wise. He possessed an independent mind and a forceful character, "it's dogged that does it" being his motto. He will be sorely missed for his clear judgment, store of good humour and warm sympathy, especially at a time like the present, when the transition to peace and the expansion of the University of Leeds are raising so many problems. R. H. EVANS

Dr. A. E. Jones

DR. ARTHUR EMRYS JONES, lecturer in mathematics at the Imperial College of Science and Technology, London, was killed in a lift accident on May 7 at the age of twenty-seven. A scholar of St. John's College, Cambridge, he secured a first class in Part II of the Mathematical Tripos in 1939, and honours in Part III in the following year. During the War he worked in the Ballistics Section of the Armaments Research Department, and was associated with J. R. Womersley in his pioneer work on the application of statistical methods to the control of variability in gun-cordite. In 1945–46 he worked at Rothamsted Experimental Station on the design of grazing experiments, and thereafter entered the Statistics Section of the Mathematical Department at Imperial College.

A thesis on continuous stochastic processes and autocorrelation theory brought him his doctorate in 1946. He had also published, in *Biometrika*, vol. 33, Part IV, a paper on the routine estimation of dispersion from large samples. At the time of his death he was working on the effects of autocorrelation on experimental design and estimation. A paper on this subject, by him, will be published shortly by the Royal Statistical Society.

What advances in mathematical statistics Dr. Jones would have made, had he lived, cannot be known. What is certain is that they would have been considerable. He leaves a wife and daughter.

We regret to announce the following deaths:

Jacques Cochon de Lapparent, *Correspondant* of the Section of Mineralogy of the Paris Academy of Sciences, on May 18, aged sixty-five.

Mr. C. A. Malcolm, C.I.E., during 1928–34 chief conservator of forests, Central Provinces, India, on June 8, aged sixty-eight.

NEWS and VIEWS

Imperial College of Science and Technology: Sir Richard Southwell, F.R.S.

In September 1948, Sir Richard Southwell relinquishes the rectorship of the Imperial College of Science and Technology, London, after a period of tenure of six years. This step he has decided to take in order to be free to carry through various research projects concerned with the methods of relaxation that have become so closely associated with his name. Six years is but a short time in which to leave an imprint on the policy and development of an institution of the magnitude and scope of the Imperial College; but there is no doubt that his influence has left its distinctive mark. During this period detailed plans have been produced for the reconstruction of the three constituent colleges on a formidable scale; and if, for reasons of national exigency, these plans will not mature during this quinquennium, they are at least ready to be transformed into reality as soon as the opportunity arises. Not unconnected with this has been the celebration of the centenary of the first beginnings of the College, and the opportunity it presented of establishing a fund that will make possible many ventures of a social and educational nature that would have been otherwise cramped or completely frustrated. Moreover, a commencement has been made with the extension of hostel accommodation for students by the foundation of Selkirk Hall. In this period also the representation of the staff on the governing body has been enlarged, so that members of the teaching staff are involved to a much greater extent than heretofore in the determination of College policy. In this connexion also Sir Richard Southwell has been responsible for the extension of deanships to the three constituent colleges, a move that has made for much closer co-ordination and collaboration than hitherto. On the side of educational policy, he has been mainly responsible for the distinct shift in the incidence of College studies, whereby further developments in advanced study and research are coming into prominence while some of the more elementary preparatory work is fading out. Finally, he has unquestionably built up a tradition of social life that is not usual or easy to develop in a college situated in the metropolis. Sir Richard Southwell can now withdraw from the hurly-burly of the administration of the College with the sure knowledge that during his six years he has helped to determine much of its future character.

Chemistry at Birmingham: Sir Norman Haworth, F.R.S.

Sir Norman Haworth, who has held the Mason chair of chemistry and the directorship of the Chemistry Department in the University of Birmingham since 1925, is to retire from office at the end of the present session. He studied at the Victoria University of Manchester and, after periods spent in Germany and at the Imperial College of Science and Technology, London, he proceeded to St. Andrews as lecturer in organic chemistry. From there he went to Armstrong College, Newcastle (University of Durham), as professor of organic chemistry (1920), and five years later he was elected to the Mason chair at Birmingham in succession to Sir Gilbert Morgan. Under Haworth's leadership the research school at Birmingham rapidly became the chief centre for structural investigation in the carbohydrate group, and the importance of his contributions in this field was recognized by the award of the Nobel Prize for Chemistry (1937). In addition to the direction of a large research school which has attracted workers from all over the world, Sir Norman Haworth has contributed greatly to developments in teaching methods and to the organisation of his department. He has held office as dean of the Faculty of Science and as vice-principal of the University of Birmingham and has served on many Government boards and committees. He is a Longstaff medallist of the Chemical Society, of which he was president during the years 1944–46. He is now a vice-president of the Royal Society, from which he has received both the Davy Medal and a Royal Medal.

In the earlier part of Sir Norman's period of office, the work of the Birmingham school was directed mainly to the determination of the structures of the simpler sugars and their derivatives. For example, the difficult problem of the ring structures in sucrose was solved, and an elegant method, involving oxidation to the aldonic acid, followed by methylation, was developed for determining the structure of reducing disaccharides. Studies were made also of acetone derivatives, sugar carbonates, anhydro sugars, partially methylated sugars and other important reference compounds; and, on the broad and firmly established basis thus laid down, the investigations were extended to the naturally occurring polysaccharides. There followed the elucidation of the general type of structure present in the macromolecules of cellulose, starch, glycogen, inulin, xylan, mannan and certain levans, and the introduction of methods for the assay of terminal groups enabled still further insight to be gained into the detailed molecular architecture of the polysaccharides. Along with these developments should be noted the determination of the structure of vitamin C and its synthesis, and the elucidation of the structures of glucosamine and chondrosamine. More recently the attention of workers in the Birmingham school has been directed towards biochemical problems, and important discoveries have been made concerning the enzymic degradation of the components of starch and their synthesis from glucose 1-phosphate. Investigations are in progress also into the structure of the highly important bacterial polysaccharides.

Prof. H. W. Melville, F.R.S.

PROF. H. W. MELVILLE, who will succeed Sir Norman Haworth at Birmingham, has made many valuable contributions to our knowledge in the field of reaction kinetics. His early work consisted in the examination of the various explosion limits in such mixtures as phosphine and oxygen. The implications of the free radical in such reactions led him to explore the mechanism of a number of photochemical reactions in which radicals are found, and here he first introduced the device of the rotating sector which has permitted us to obtain life-times of transient species with remarkable accuracy.

Some fifteen years ago when deuterium and its compounds became readily available, Melville examined a number of gas reactions in which hydrogen could be replaced by deuterium in order that the relative importance of mass and zero-point energy could be evaluated, thus throwing light on the detailed mechanism. With this background Melville felt that he was in a position to take up the suggestion that the study of the more complex processes of polymerization and macromolecular condensation might, if carried out in the gaseous phase, yield valuable information on the nature of the chain reactions involved. He threw himself into this work, both in the Department of Colloid Science at Cambridge and later at the University of Aberdeen, with his characteristic energy, and the continuous stream of papers in this field coming from these laboratories bears witness to his versatility and ingenuity in unravelling the complexities of these reactions. The School of Physical Chemistry which he created at Aberdeen combined in a characteristic manner the experimental with the theoretical. Birmingham is to be congratulated in its choice.

Genetics at Birmingham: Dr. K. Mather

DR. KENNETH MATHER, who has been appointed to the chair of genetics now established in the University of Birmingham, is known for his, in some respects, revolutionary outlook on this subject. Dr. Mather derives this outlook from a fusion of several of the main streams of thought in biology. He went from Manchester in 1931 to work at the John Innes Horticultural Institution, where he obtained a thorough grasp of the chromosome theory of heredity as it was being developed there at the time. In 1933 he went for a year to Sweden, where he gained a great deal from studying the methods of plant breeding used at Svalöv and by that notable sugar beet breeder, Dr. J. M. Rasmusson. In 1934 he took a post with Prof. R. A. Fisher, under whom he became familiar both with the breeding of mice and the still rapidly developing technique of statistical genetics, to which he began to make serious contributions. In 1937 he spent a year with Morgan and East in the United States. Finally, in 1938 he returned to take up the post of head of the Genetics Department at the John Innes Institution. There he has remained for ten years carrying out (with a success that has now been recognized) the very definite purpose and programme that he had in mind when he went there—that of combining biometry and genetics into a single efficient tool for the study of evolution, the practice of plant and animal improvement and the understanding of biology as a whole. During these years, however, Dr. Mather, like other workers in this field, has been painfully conscious of the widening gap between the advances of genetic research and the status of genetic teaching in the universities. In his new post he will have an opportunity of narrowing this gap and of rendering a great service to the University of Birmingham.

British Jute Trade Research Association

THE British Jute Trade Research Association has acquired premises on the Dundee Industrial Estate to replace the temporary accommodation at present occupied in Bellfield Street, Dundee, following negotiations with the Scottish Industrial Estates, Ltd., and various Government committees. The new buildings will be utilized for future research and development in connexion with the activities of the Association, and it is hoped to be in occupation early in 1949. When completed, the Laboratory Section will cover an area of approximately 6,500 sq. ft., and will contain physical and chemical laboratories, photographic and physical dark rooms, a room where constant temperature and humidity can be maintained, machine rooms, library and administration. A separate Engineering Development Section will in the first instance cover an area of some 2,000 sq. ft., and the personnel in this Section will work in very close collaboration with the Laboratory scientific staff. The remaining space of 14,000 sq. ft. will be devoted to the Processing Section, in which will be installed a complete range of all jute processing, weaving and finishing machinery. The building will be the first industrial research laboratory of its kind to be set up in Scotland for co-operative research, and is supported by practically the whole of the jute interests. The importance of scientific research to the industry is being realized more and more, and the support for the project illustrates the desire of the industrialist to utilize every possible means to increase efficiency and quality of product.

Science and Technology in China

THE Natural Science Society of China has recently inaugurated a new bulletin, *Science and Technology in China*, of which two numbers of the first volume have already appeared. It is very well printed and produced and contains many interesting articles. In the April issue, Dr. Mao I-Sheng writes on the present position and outlook of research in the engineering sciences in China; Dr. Li Ching-Yuan on current mineral exploration in China; and Dr. Jen Mei-O on the progress of land utilization surveys in the south-west part of the country. The work of the Scientific Office of the British Council in China is reviewed at some length, and the rest of the bulletin consists of research reports similar to the correspondence columns of *Nature*, together with abstracts of papers read at the February 1948 meeting of the Chinese Chemical Society at Nanking. While China has had for many years its chief scientific journal analogous to *Nature*, namely, *Ko-Hsueh*, this has always been and will continue to be published in the Chinese language. There has therefore been room for a periodical, perhaps of a smaller character but in the English language, and the new venture deserves every success. The chief editor is Dr. Wu Hsueh-Chou (director of the Chemical Institute of Academia Sinica), and inquiries and subscriptions should be addressed to him at that Institute, 320 Yoyang Road, Shanghai. Foreign subscribers may also communicate with Mr. S. H. Doo, 7137 Pennsylvania Avenue, Pittsburgh 8, Pa., U.S.A. The annual subscription is 2.00 American dollars per annum, or its equivalent.

Cambridge University Educational Film Council

THE Cambridge University Educational Film Council was formed in February 1947 "to promote the use of films in higher education and for the purpose of academic research". The ultimate aim of the Council is the establishment by the University of Cambridge of a Film Centre with adequate facilities for the production, projection and storage of educational films; meanwhile, it is collecting information about educational films and film strips already in existence, giving technical advice to university departments wanting to make or project films, encouraging professional film units to consult with university teachers on the films required and their economic distribution, and arranging for the exchange of films with academic bodies of all kinds in Great Britain and other countries. Membership is open to members of the University, and all Faculties and Departments at Cambridge are automatically members of the Council. The General Board of Faculties and the Cambridge University Press appoint representatives to its executive committee. A memorandum on the provision of cinematograph facilities at Cambridge has been submitted by the Council to the General Board. The Council has already produced for distribution within the University a list of sources from which films suitable for use in university education can be procured, and obtained particulars of films made in Cambridge; it has also set up a library of film catalogues from Great Britain and abroad, and collected information regarding the use of films in a number of university departments outside Cambridge. At the suggestion of the Council, a conference on the use of films in universities was convened by the British Film Institute and the Scientific Film Association in November 1947, and a Universities Film Council for the British Isles has been established.

Televizing the Museum

THE Cleveland Museum of Natural History has again shown commendable enterprise in extending its educational influence to a much larger public than habitual museum visitors (*The Explorer*: Bulletin of the Cleveland Museum of Natural History, 94; 1948). Through the courtesy of the American broadcasting station, W.E.W.S., it is now presenting a monthly television programme called "Your Museum of Natural History". Two general programmes have already been televized, one dealing with the timely subject of the Navaho Indians and the other with the recent gift to the Museum of the works of John J. Audubon, including the famous early nineteenth-century English prints of Havell. There is also a regular weekly television programme built round the Museum's explorers clubs for children; subjects so far presented include the Apache Indians, fur-bearing mammals, care of pets, bird migration and signs of spring.

Maps of Svalbard

NORGES SVALBARD og Ishavs-undersökelser, now known as Norsk Polarinstitutt, has begun the issue of a detailed map of Svalbard in folded sheets, each covering about 1,300 kilometres. The scale is 1 to 100,000. The map is based on a network of trigonometrical points and constructed from aero-photograms taken by oblique photography. It is in black for moraines, glacier limits and lettering, blue for seas, streams, lakes and glacier contours, brown for form lines and contours, and green for glacier slopes. In addition to the old place names in their accepted Norwegian forms, a number of new names have been added. The first sheet (price 3 kroner) covers the little-known Sörkapp area as far north as Hornsund and is numbered C.13.

Canadian National Research Council Scholarships

SCHOLARSHIPS have been granted by the National Research Council of Canada to 169 graduates for postgraduate studies during the academic year 1948–49. There are twenty-five fellowships at 900 dollars, sixty-three studentships at 750 dollars, seventy-five bursaries at 450 dollars tenable at Canadian universities, and ten special scholarships ranging in value from 500 to 1,000 dollars awarded for study abroad. The nominal value of all scholarships for the year is 107,900 dollars. Thirty departments of science are represented in the applications approved this year. Chemistry in its several branches is represented by 65 and physics by 62. The remaining awards are widely distributed in the other sciences as follows: agricultural bacteriology, 1; anatomy, 3; applied mathematics, 1; biology, 2; communications engineering, 2; dental bacteriology, 1; entomology, 1; experimental medicine, 1; genetics, 1; geology, 6; mathematics, 4; mathematical statistics, 3; medical research, 1; metallurgy, 1; mineralogy, 2; physiology, 3; physical metallurgy, 1; plant pathology, 1; and zoology, 7.

Conference on Civil Engineering Problems in the Colonies

A CONFERENCE on Civil Engineering Problems will be held at the Institution of Civil Engineers, Great George Street, Westminster, S.W.1, during July 19–23, at which a number of papers on subjects of importance in Colonial development will be read and discussed. Mr. A. Creech-Jones, Secretary of State for the Colonies, has consented to open the Conference on July 20, at 10.15 a.m. Among the topics to be discussed are: development planning with special reference to physical development, the East African groundnuts scheme, road improvement in Jamaica, railway gauge in tropical Africa, railways and roads in Malaya, problems of labour and material in West Africa, Colonial housing, and engineering aspects of tropical hygiene. The Conference is open to members of the Institution, to engineers and to other officers specially interested who are employed in the Colonial Service, and to other engineers who are otherwise engaged in civil engineering work in the Colonies. Application forms can be obtained from the secretary of the Institution of Civil Engineers.

Unione Matematica Italiana

THE third national congress of the Unione Matematica Italiana is to be held at Pisa during September 23–36. The congress will be devoted to a comprehensive review of the Italian contributions to mathematics during the last few years, and particularly in so far as they are linked up with the mathematical activities of other countries during the same period. In addition to papers on pure and applied mathematics, special sections will deal more particularly with analysis, geometrical mechanics, mathematical physics, actuarial mathematics and probability, geodesy, astronomical and astrophysics, mathematics applied to engineering, the history of mathematics and didactics. The Unione Matematica Italiana cannot offer any financial assistance to visitors; but it is expected that expenses for the stay at Pisa will be low. All inquiries relating to the Congress should be sent to Prof. Luigi Berzolari, Universitá di Bologna, Bologna, president of the Unione Matematica Italiana, who is acting as secretary to the Congress.

British Thomson-Houston Summer School

The British Thomson-Houston Co., Ltd., Rugby, is holding a summer school in electrical engineering during July 12–16. Sir Henry Tizard is to open the school, which will consist of lectures and discussions on such topics as electronic control of motors, magnetic sheet steel, examination of large forgings, high-power pulse generation, power system analysis, switchgear problems, betatron developments, electric discharge and fluorescent lamps, etc. Tours of the Company's works have also been arranged. The purpose of the school is to enable engineers in academic posts to obtain first-hand knowledge of the more important recent advances in electrical engineering; attendance is by invitation of the Company. Further particulars can be obtained from the Manager, Publicity Department, British Thomson-Houston Co., Ltd., Rugby.

Seventh International Congress of Food and Agricultural Industries

The Seventh International Congress of Food and Agricultural Industries will meet in Paris during July 12–18 at the invitation of the French Government. Among the subjects for discussion are: the role of vitamins, hormones and trace-substances, ionic exchanges in sugar-refining, fermentation, homologization of malt, bread-making qualities of wheats, rational use of the combined harvester, improvements in the dairying and canning industries, advances in the feeding of livestock, digestibility of fats and oils, destruction of organic matter in waste waters, standardization of statistical methods, and technical instruction. Further details can be obtained from the Commission Internationale des Industries Agricoles, 18 Avenue de Villars, Paris.

University of London

The following appointments in the University of London have been announced: Dr. G. C. McVittie, to the University chair of mathematics tenable at Queen Mary College as from October 1; since 1936 he has been reader in mathematics at King's College, but during the War was engaged on work at the Government Communications Headquarters. Dr. Sidney Smith, honorary professor of Near Eastern archæology at the Institute of Archæology, London, to the University chair of ancient Semitic languages and civilizations tenable at the School of Oriental and African Studies, as from October 1.

The title of professor emeritus of physics in the University has been conferred on Dr. Frank Horton, professor of physics at Royal Holloway College during 1914–46 and vice-chancellor of the University during 1939–45. The title of professor emeritus of chemistry in the University has been conferred on Prof. T. S. Moore, professor of chemistry at Royal Holloway College during 1914–46.

The degree of D.Sc. has been conferred on Dr. Adrien Albert (School of Pharmacy), Louis Essen and A. E. J. Went.

The Night Sky in July

New moon occurs on July 6d. 21h. 09m., U.T., and full moon on July 21d. 02h. 31m. The following conjunctions with the moon take place: July 5d. 16h., Venus 8° S.; July 5d. 18h., Mercury 8° S.; July 9d. 06h., Saturn 4° S.; July 11d. 16h., Mars 3° S.; July 18d. 01h., Jupiter 4° N. Mercury is too close to the sun in the early part of the month to be observed, but in the middle of the month the planet rises an hour before sunrise and attains its greatest westerly elongation on July 16. At the end of the month Mercury rises at 3h. 16m., about an hour before sunrise. Venus rises about a quarter of an hour before the sun on July 1 but can be observed later in the month, rising at 2h. 28m. and 1h. 41m. on July 15 and 31, respectively. The planet attains its greatest easterly elongation on July 16 and its greatest brilliancy on July 31, when its stellar magnitude is −4·2. Mars sets at 23h. 10m., 22h. 30m. and 21h. 45m. at the beginning, middle and end of the month, respectively, and can be seen for a short time in the western sky after sunset. Jupiter, in the constellation of Ophiuchus, is visible during the early part of the night, setting at 2h. 40m., 1h. 36m. and 0h. 33m. at the beginning, middle and end of the month, respectively. Owing to its large declination south, nearly 23°, the planet is not very well placed for observation in high northern latitudes. Saturn sets about an hour before Mars and cannot be observed very long after sunset; at the end of the month it sets a little more than half an hour after the sun. No occultations of stars brighter than magnitude 6 take place in July. The earth reaches aphelion on July 4, when its distance from the sun is 94,561,000 miles.

Announcements

Dr. Julian Huxley has been elected *Correspondant* for the Section of Anatomy and Zoology of the Paris Academy of Sciences.

The honorary degree of D.Sc. of the University of Oxford has been conferred on Dr. Isaiah Bowman, president of Johns Hopkins University, and president during 1931–34 of the International Geographical Union; and on Prof. Linus Pauling, professor of chemistry and director of the Gates and Crellin Chemical Laboratories, California Institute of Technology, who is now George Eastman visiting professor at Oxford.

Mr. E. I. R. MacGregor has been appointed assistant civil air attaché at the British Embassy, Washington, in succession to Mr. N. Bicknell, who is entering the Foreign Service. Mr. MacGregor took first-class honours in physics at the Queen's University, Belfast, and after a short period on television research with Electric and Musical Industries, Ltd., he entered the R.A.F. Education Service (1936). During 1941–46 he served on the British Air Commission and R.A.F. Delegation at Washington.

A new exhibit of Protozoa in the Zoological Department of the British Museum (Natural History) has been opened to the public. It adjoins the Coral Gallery, which was reopened a few weeks ago. Owing to the minute size of these organisms, all but a few of the larger marine forms are displayed either by means of enlarged glass models or by tinted line drawings.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Carbon Monoxide Affinity of Chlorocruorin and Hæmoglobin

Chlorocruorin, the green-red respiratory blood pigment of certain marine annelid worms, is the only known substance built on the same plan as hæmoglobin. Like most kinds of hæmoglobin, chlorocruorin has a higher affinity for carbon monoxide than for oxygen[1]. This property, valueless to animals, is utilized in experimental work to eliminate the possible respiratory activity of these pigments and so to test their functional significance[2,3]. The relative affinity of chlorocruorin (*Ch*), or of hæmoglobin, for the two gases in the reversible reaction

$$\mathrm{O}.Ch + \mathrm{CO} \rightleftharpoons \mathrm{CO}Ch + \mathrm{O}_2$$

is given by the equilibrium constant K in the equation

$$K = [\mathrm{CO}Ch]/[\mathrm{O}.Ch] \times p\,\mathrm{O}_2/p\,\mathrm{CO},$$

from which it is seen that when the pigment is 50 per cent in the carboxy state and 50 per cent in the oxy state, K becomes the ratio of oxygen to carbon monoxide.

Krogh[4] was the first to show that different kinds of animals have different values of K. For the hæmoglobin of human blood, K has been found to be 235 or 246 (Douglas, Haldane and Haldane)[5], 240 (Killick)[6] or 490 (Anson *et al.*)[7]. The values for certain other hæmoglobins have been found to be as high as this or higher. For yet other hæmoglobins the values of K are low, that of horse muscle hæmoglobin (myoglobin)[8,9] being 14–51, of the hæmoglobin of leguminous root nodules[10] 37, and of the larva of the horse bot-fly (*Gastrophilus*)[11] 0·67. With these very considerable known differences in the relative affinity of hæmoglobins for carbon monoxide and oxygen, it was of interest to find the values of the equilibrium constant for several invertebrate hæmoglobins and for a chlorocruorin.

The blood of each kind of animal was diluted in $M/20$ phosphate buffer at *p*H 7·3 and then centrifuged and filtered to give a limpid solution. Some of this was put into a modified Thunberg tube with a 2 cm. optical cell, and the concentration was adjusted to give an optical density ($\log_{10} I_0/I$) of about 1·5 at the α-band, measured with a Hilger – Nutting visual spectrophotometer. After equilibration at 20° C., with air in the case of hæmoglobin, or oxygen for chlorocruorin (which cannot be saturated with oxygen at atmospheric partial pressure[1]), the densities were determined at wave-lengths 561 and 578 mμ for hæmoglobin, or 590 and 606 mμ for chlorocruorin. Previous plotting of the absorption curves of the oxy and carboxy compounds had shown that the two wave-lengths mentioned are those at which the light absorption differs most. The Thunberg tube was then evacuated, filled with an appropriate mixture of oxygen and carbon monoxide to obtain about a half-and-half mixture of the two compounds of the pigment, and the solution equilibrated with the gas by rotation for half an hour in a water thermostat at 20° C. in dim light, after which the changed densities were determined at the same two wave-lengths. (Although both carboxy compounds are dissociated by light[12,1], there was no progressive change in the spectrophotometer readings, even when the solution was left exposed to the lamp for a quarter of an hour; doubtless measurable changes only occur in thin layers.) The third step was to evacuate the tube anew, fill it with pure carbon monoxide, re-equilibrate and again measure the two densities. From the six density measurements the relative concentrations of the oxy and carboxy compounds in the solution in equilibrium with the gas mixture can be calculated by a formula given by Keilin and Wang[11], and from this the value of K in the equation above is directly deducible.

The following are the values of K which were obtained, in decreasing order of magnitude, the first being that of chlorocruorin, the remainder all of blood hæmoglobins: *Branchiomma vesiculosum* (Montagu), 570; *Chironomus dorsalis* Mg., 400; horse, 280; man, 230; *Arenicola marina* L., 150; *Tubifex* sp., 40; *Planorbis corneus* L., 40; rabbit, 40. From five to eleven determinations were made for each of the different animal forms. The values of K obtained for each of them varied considerably, and as there were not enough values to give standard errors, the means have been rounded to the nearest 10. There are several surprises in the results. The values differ greatly. The figure for man is virtually the same as those previously found by Douglas, Haldane and Haldane[5], and by Killick[6], which are given above. Anson *et al.*[7], who obtained a much higher value for man, agree with me in placing the horse a little above man and the rabbit much lower. The highest hæmoglobin value is that of the bloodworm, the larva of a midge, *Chironomus*. But chlorocruorin has a far higher value than any hæmoglobin. The lowest values which I found, namely, those of the oligochæte worm *Tubifex*, of the pond snail *Planorbis* and of the rabbit, are about the same as for the muscle hæmoglobin of the horse and the hæmoglobin in the root nodules of leguminous plants.

It is not possible at present to correlate the diverse values of K with other properties of these hæm pigments. *Chironomus*, with the highest value of K for any hæmoglobin, has also the highest oxygen affinity of a blood hæmoglobin[13], but chlorocruorin, with a still higher K, has an oxygen affinity much lower than any hæmoglobin[14]. The hæmoglobin in the muscle of the horse has a higher oxygen affinity than that of the blood, but a much lower K. The highest value of K in a hæmoglobin (*Chironomus*) and the lowest value (*Gastrophilus*) are both in the Insecta, in which class hæmoglobin is extremely rare. Keilin and Wang[11] have shown that there is no relation between K and span (difference between wave-lengths of oxy and carboxy α-bands) as was once thought. It is for future biochemical and physicochemical research to find the meaning of the very diverse values of K.

My sincere thanks are due to Prof. D. Keilin and Dr. E. F. Hartree for advice and help.

H. Munro Fox

Molteno Institute, Cambridge.

May 14.

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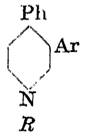
Synthetic Analgesics

ATTEMPTS to prepare new analgesics have, for many years, been based almost exclusively on the morphine molecule, the peripheral groups of which may be modified considerably with relatively little effect on the biological activity. The synthetic drug 'Pethidine' (ethyl 4-phenyl-1-methylpiperidine-4-carboxylate) has several structural features in common with morphine, and there is a considerable body of evidence which relates analgesics of the piperidine type to the morphine model[1-4]. The recently discovered 'Amidone' (*dl*-2-dimethylamino-4 : 4-diphenylheptan-5-one) is also a potent analgesic. We have examined three types of compound for analgesic, antispasmodic and local anæsthetic action. Although none of these compounds is closely related to morphine, several have an analgesic potency equivalent to or approaching that of 'Pethidine'.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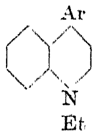
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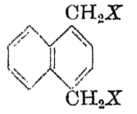
III

The synthesis of compounds of type I has already been reported[5]. Compounds of type II (in which Ar=Ph, or *p*-MeO.C_6H_4—) have been prepared by hydrogenation of the oximes of ethyl β-(2-keto*cyclo*hexyl)-β-arylpropionates, and the *p*-methoxy compound has also been demethylated to the corresponding *p*-hydroxy derivative[6]. The preparation of our compounds of type III has not previously been described. 1 : 4-*Bisdiethylaminomethylnaphthalene hydrochloride* (X = —NEt) was obtained as colourless needles, m.p. 229–230°, by condensing 1 : 4-bischloromethylnaphthalene[7] with diethylamine. (Found : C, 63·3 ; H, 8·4 ; N, 7·0. $C_{20}H_{32}N_2Cl_2.\frac{1}{2}H_2O$ requires C, 63·1 ; H, 8·7 ; N, 7·3 per cent. The *picrate* formed yellow needles, m.p. 203–204°. Found : C, 50·65 ; H, 4·6 ; N, 14·9. $C_{32}H_{36}O_{14}N_8$ requires C, 50·8 ; H, 4·8 ; N, 14·8 per cent.) 1 : 4-*Bis*isothio*carbamidomethylnaphthalene hydrochloride* (X = —SC(=NH)NH_2) was obtained as colourless plates, m.p. 270–272°, from the bischloromethyl compound and thiourea. (Found : C, 44·8 ; H, 4·6 ; N, 14·5. $C_{14}H_{18}N_4Cl_2S_2$ requires C, 44·6 ; H, 4·8 ; N, 14·8 per cent. The *picrate* formed yellow needles, m.p. 219–220°. Found : C, 41·2 ; H, 3·0. $C_{26}H_{22}O_{14}N_{10}S_2$ requires C, 41·0 ; H, 2·9 per cent.)

The L.D.$_{50}$ in mgm./kgm. was determined by intraperitoneal injection in white mice. Of the N-alkyl-3 : 4-diarylpiperidines (type I), increase in the length of the alkyl chain decreased toxicity from 90 mgm./kgm. for 3 : 4-diphenyl-1-methylpiperidine to 250 mgm./kgm. for 3 : 4-diphenyl-1-*n*-butylpiperidine. In group II, 1-ethyl-4-(*p*-hydroxyphenyl)decahydroquinoline (120 mgm./kgm.) was less toxic than the unsubstituted 4-phenyl compound (80 mgm./kgm.). In group III, the thiourea derivative (61 mgm./kgm.) was much more toxic than the diethylamino derivative (370 mgm./kgm.). The Straub tail phenomenon was present in greater or less degree in mice poisoned with various members of each group. Compounds of types I and II mainly produced motor excitement (as does 'Pethidine') ; group III was depressant.

TOXICITY AND ANALGESIC ACTIVITY

Name	Relative analgesic potency (mice)	L.D.$_{50}$ (mgm./kgm.) intraperitoneal injection, mice
3 : 4-Diphenyl-1-methylpiperidine HCl	stimulant	90
3 : 4-Diphenyl-1-ethylpiperidine HCl (*A* isomer)	0·6	100
3 : 4-Diphenyl-1-ethylpiperidine HCl (*B* isomer)	0	130
3 : 4-Diphenyl-1-*n*-butylpiperidine HCl	0·6	250
4-Phenyl-3(*p*-methoxyphenyl)-1-ethylpiperidine HCl	0·4	150
4-Phenyl-1-ethyldecahydroquinoline HCl	0·6	81
4-(*p*-Methoxyphenyl)-1-ethyl-decahydroquinoline HCl	0·7	100
4-(*p*-Hydroxyphenyl)-1-ethyl-decahydroquinoline HBr	0	120
1 : 4-Bisdiethylaminomethyl-naphthalene HCl	1·0	370
1 : 4-Bis*iso*thiocarbamidomethyl-naphthalene HCl	1·0	61
'Pethidine'	1·0	150

Drugs in group I were irritant when placed in the conjunctival sac of rabbits, and neither group I nor group III showed any evidence of local anæsthetic properties. Group II drugs were less irritant than group I and had some effect as anæsthetics. The most powerful, 1-ethyl-4-(*p*-methoxyphenyl) decahydroquinoline, had a potency of 10 per cent of cocaine hydrochloride. The compounds were tested for antispasmodic activity against barium chloride (5 mgm.), histamine base (1 μgm.), acetylcholine (1 μgm.) in a 75 ml. bath. None of the compounds was highly specific, but all had some antispasmodic activity. Group I compounds were most active, 3 : 4-diphenyl-1-ethylpiperidine having 1/33 the activity of benadryl against spasm induced by histamine ; against acetylcholine, 1/250 the activity of atropine sulphate ; against barium, 1/6 the activity of 'Pavatrine'. Group II and group III were of a similar order of potency against barium-induced spasm, but much less active against histamine and acetylcholine. The analgesic potency was estimated according to the method of Davies *et al.*[8], except that mice were used instead of rats. Group III drugs were found to be equal in potency to 'Pethidine'. Groups I and II showed lesser and varying degrees of potency, and 3 : 4-diphenyl-1-methylpiperidine is a stimulant. The considerable analgesic activity of 1 : 4-bisdiethylaminomethylnaphthalene is of interest, as this is a new class of compound to exhibit pronounced activity.

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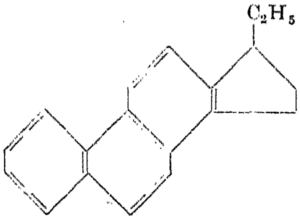
Constitution of Conessine

PREVIOUS work has shown that the alkaloid, conessine, is a ditertiary base, $C_{24}H_{40}N_2$, containing three N-methyl groups and one ethylenic linkage, and our work now establishes a relationship with the growing class of steroid bases. The absence of oxygen is noteworthy ; this is uncommon in the alkaloids, and the natural occurrence of an oxygen-free steroid derivative has not been reported previously.

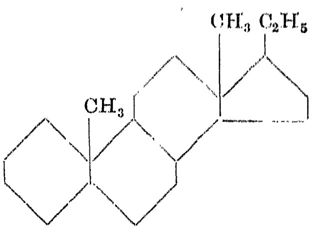
The first indication of the structure came from an examination of the selenium dehydrogenation products of the hydrocarbon mixture, $C_{21}H_{30}$, obtained by pyrolysis of conessine dihydriodide[1]. Careful fractionation of the products yielded a crystalline hydrocarbon, $C_{19}H_{18}$, m.p. 78–79°, which showed many similarities with synthetic[2] 3′-ethylcyclopentenophenanthrene (I), m.p. 84·5–85·5°.

Although the hydrocarbons and their derivatives with nitrohydrocarbons gave no depression in melting point on admixture, it was not possible to raise the melting point of the hydrocarbon obtained from conessine, even after recovery from the nitrohydrocarbon complexes ; and, as some discrepancies were observed on comparison of the ultra-violet absorption spectra and X-ray photographs of the two hydrocarbons, the identity was not convincingly established.

By subjecting conessine to successive degradations by the Hofmann and Emde processes, Späth and Hromatka[3] obtained a hydrocarbon, $C_{21}H_{30}$, which gave a hexahydroderivative, $C_{21}H_{36}$, m.p. 56–58°. In our hands this reduction has yielded approximately equal amounts of two isomeric hydrocarbons, $C_{21}H_{36}$, m.p. 56–58° and 83–84° respectively. The former is presumably identical with the hydrocarbon obtained by Späth and Hromatka, and the isomer, m.p. 83–84°, is identical, chemically and physically, with *allo*pregnane (II), prepared from progesterone by described methods[4].



I



II

The carbon atoms of conessine are therefore accounted for by the *allo*pregnane structure (II) and the three N-methyl groups, but the positions of the ethylenic linkage and the points of attachment of the basic centres are still uncertain. Structural investigations on conessine and its relatives are being developed in several directions, and a full account will be published elsewhere.

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Quantitative Electron-Density Contour Delineation in the Electronic Fourier Synthesizer for Crystal Structure Analysis

THE electronic Fourier synthesizer for crystal structure analysis reported earlier from this laboratory[1] has been modified so that contour lines of projected electron densities from one cell on any desired lattice plane can be accurately delineated.

It was originally intended that a pattern corresponding to a Bragg photographic synthesis be presented on a cathode ray tube screen ; and the remark was made in the early report that such a presentation should not be considered as a replacement for accurately calculated contour maps, due to obvious limitations on linearity and range of screen response. This inexactness is removed by triggering coincidence circuits, set at predetermined voltage levels, directly from the voltage signal formerly applied for intensity modulation to the cathode ray tube grid. The circuits produce 1 microsec. pips each time the synthesized signal crosses one of the preset voltage levels, and these are applied to the cathode ray tube grid in place of the entire synthesis signal.

Fig. 1

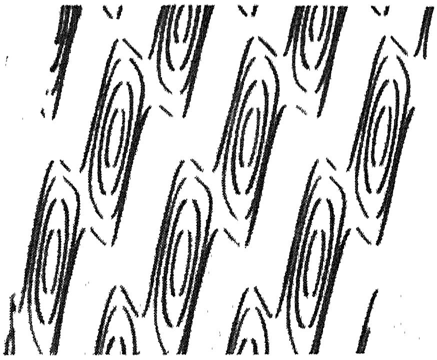

Fig. 2

The contouring technique has been applied to the model synthesizer which was demonstrated at the Annapolis meeting of the Crystallographic Society of America on March 20, 1947[2]. Fig. 1 shows an intensity-modulated pattern corresponding to the superposition of (2, 0, 3) and (1, 0, $\bar{3}$) fringes, for a c-axis projection of a monoclinic cell with $a : c \approx 1·0 : 1·1$ and $\beta \approx 81°$. Fig. 2 shows a four-line contour map of the same projection. (It may be recalled that the axial ratio and angle of a projection can be adjusted at will on the synthesizer[1].) These photographs are obtained directly from the presentation tube.

The apparent difference in contours of some peaks in Fig. 2 is due to non-linearity of sweep in the model synthesizer. In the large synthesizer for a 20 by ± 20 matrix of terms, construction of which is in progress, these and other imperfections are removed. Co-ordinate lines (of controllable intensity) are also available in the large device, so that accurate location of peaks is possible. The size and conditions of operation of the final synthesizer will be such that as many contour lines as are desired can be accommodated. The zero-level of electron density can be set in through adjustment of the overall D.C.-level of the synthesized signal.

Development of the electronic Fourier synthesizer is supported by the Office of Naval Research, Navy Department, Washington, D.C., under Contract No. N7onr-377.

The simple contouring procedure grew out of conversations with Prof. A. L. Patterson, of Bryn Mawr College. The long-standing interest, support and valuable suggestions of Prof. Patterson in this entire development are much appreciated.

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[1] Pepinsky, R., *J. Appl. Phys.*, **18**, 601 (1947).

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Low-Angle X-Ray Diffraction Pattern of Collagen

IT is generally accepted that the low-angle X-ray diffraction pattern of collagen is unidimensional in the direction of the fibre axis with a fundamental period of 640 A. [1]. Variations in the water content of the fibre, effected by a control of the ambient relative humidity during the X-ray exposure, alter this spacing from 628 A. at 2 per cent relative humidity to 672 A. at 100 per cent relative humidity. This continuous increase in spacing is accompanied by drastic fluctuations in the relative intensities of the various orders.

If the uptake of water by the collagen produced a uniform extension of the molecule, no change in the intensities of the orders in the diffraction pattern would be observed. The intensity variations of the reflexions which do occur can only be explained by a non-uniform alteration in the electron density. As the most significant intensity changes occur in the low-order reflexions, the increase in spacing brought about by water absorption could be interpreted as water entering between the collagen molecules, thus influencing molecular packing. Any non-uniform change in the molecular configuration, such as an alteration in the spacing of certain atomic groups, would occur over relatively short distance in the molecule and would affect the intensities of the high-order reflexions accordingly. Perutz[2] has observed similar effects in the variations in the intensities of reflexions in the X-ray diffraction patterns of crystalline proteins.

The source of collagen used for this X-ray diffraction study was kangaroo tail tendon, since a high degree of orientation is present in the natural state of the material. By staining all the samples with an unbuffered 1 per cent solution of phosphotungstic acid, the intensity of all the reflexions was increased (thus reducing the required exposure time), with no apparent alteration of the diffraction pattern.

INTENSITY OF ORDERS

Relative humidity	100%	100%	90%	55%	30%	20%
Order number						
2	2	1	6	13	7	9
3	21	24	21	16	13	17
4	5	6	13	12	9	14
5	58	53	36	13	14	12
6	14	13	28	26	24	39
7	30	31	22	12	12	13
8	14	18	18	12	10	12
9	29	29	27	18	13	14
10	5	4	4	2	2	1
11	8	9	9	6	3	4
12	8	8	4	3	3	3
13	5	4	5	5	3	2
14	2	3		2		2
15	5	6		3		2
16	2	2		2		1
17	4	4		4		2
18	4	4		3		
19	4	5				2
20	4	5				
21	3	1				
22	3	3				
23	1	1				
24	2	1				
25	2	3				
26	2	3				
27	2					
Fundamental spacing in A.	672	666	655	646	636	630

The accompanying table indicates the humidities at which the diffraction patterns were photographed, the corresponding fundamental spacings, and the intensities of the various orders as measured by densitometric methods. Accurate comparison of these films is not possible because of variations in sample thickness and in film development. Recently, a second series of diffraction patterns has been photographed in which the same sample was used throughout, and all films were processed simultaneously. This procedure permits the desired accurate comparison of intensities. Further experiments are now in progress.

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[1] Bear, R. S., *J. Amer. Chem. Soc.*, **66**, 1297 (1944).

[2] Boyes-Watson, J., Davidson, E., and Perutz, M. F., *Proc. Roy. Soc.*, A, **191**, 83 (1947).

X-Rays and the Eigen-Vibrations of Crystal Structures

IN evaluating the effect of the atomic movements in a crystal on the propagation of a beam of X-rays through it, such of these movements as may be identified with the elastic modes of vibration of the solid may be taken up first for consideration. Each of these modes presents a distinctive pattern of nodal surfaces, the frequency of the oscillation being the same everywhere and the phase being opposite in every pair of adjacent cells in the pattern. The configuration of the nodal surfaces in any given mode is determined by various *macroscopic* factors, namely, the form of the crystal, the external boundary conditions and the elastic anisotropy, besides being dependent on the frequency of the mode. Hence, it would bear no particular relation to the atomic architecture of the crystal and would also be different for each of the numerous possible modes. These circumstances have important consequences in relation to the optical aspects of the problem. Each atom in the track of the X-ray beam may be considered as a source of secondary radiations of frequencies ν, $\nu + \nu^*$ and $\nu - \nu^*$, ν being the frequency of the X-radiation and ν^* that of the elastic vibration under consideration, and their effects have to be summed up over the illuminated volume. Since the amplitudes and phases of the radiations of modified frequency depend on the amplitudes and phases of the atomic movements, they would vary from atom to atom in a manner determined by the configuration of the nodal pattern, and hence would be different for each different ν^* and in no case would be definitely correlated with the internal architecture of the crystal. It follows that these scattered radiations cannot possibly give rise to any geometric diffraction pattern exhibiting an observable relationship to the structure of the crystal.

It remains to consider the possible vibrations in the solid which cannot be described as elastic modes, but which, on the other hand, are specifically related to the structure of the crystal and may therefore be designated as its eigen-vibrations. That such vibrations exist is proved by spectroscopic investigations, and their number and nature have been investigated by me[1] with results which have found experimental confirmation in various cases[2]. Since these eigen-vibrations are specifically related to the structure of the crystal, the secondary radiations of modified frequency resulting therefrom should be capable of giving rise to geometric diffraction patterns having a recognizable relationship to the internal architecture of the crystal. Theoretical considerations thus lead us to recognize the fundamental connexion between the eigen-vibrations of crystal structures and the dynamic X-ray reflexions exhibited by them. The existence of such a relationship and the possibility of the eigen-vibrations being excited even in the absence of thermal agitation first become apparent from the experimental facts discovered in the case of diamond by the present writer and Dr. P. Nilakantan[3].

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[2] *Proc. Ind. Acad. Sci.*, A, **26**, 339 (1947).

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Observations of Scatter Clouds

The observations made recently by P. Millman and his colleagues in Canada[1] are of particular interest to me. I have made many observations of these scatter clouds on waves of about 8 or 9 Mc./s. Thousands of photographs have been obtained, and an explanation of the effect of the clouds upon long-distance transmission has been given[2].

Although there is strong evidence that ultra-short-wave radar transmission is connected with meteors, the results of Millman and his colleagues show very clearly that scatter clouds are not only produced by meteors. I have shown that there is a large increase in these scatter clouds before a Dellinger fade (see Figs. 1 and 2). In Fig. 1 we see a number of scatter clouds which are not associated with visible meteors. The visible meteors are shown by marks at the edge of the film. In Fig. 2 we see a number of scatter clouds which occurred just before a Dellinger fade.

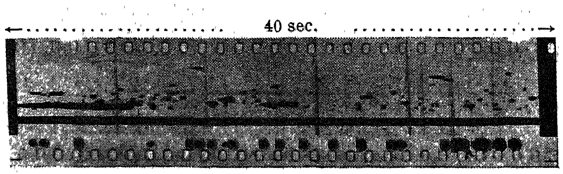

Fig. 1. G.M.T. 0130–0200, Nov. 15, 1937. Ongar, GOX, 32·35 m.

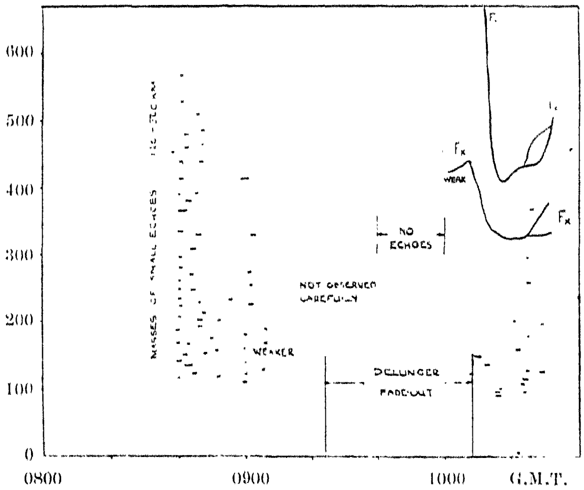

Fig. 2

The mechanism I conceive of the production of scatter clouds in Dellinger fade conditions is as follows. There is a disturbed condition of the sun before, during and after Dellinger fades, with a large amount of ultra-violet radiation from it. This will produce photo-ionization in the particles of cosmic dust suspended at about 100 km. height. Before a Dellinger fade, such particles will produce showers of photo-electrons, and these will produce localized scatter clouds.

There are four main effects observed by Millman and his colleagues, and they can all be explained by the theory of the evaporation of meteors[3], the conditions obtaining during Dellinger fades and the physics of scatter clouds. They are:

(1) The absence of correlation of scatter clouds with meteors. They can equally well be associated with Dellinger fades.

(2) The presence of two types of scatter cloud in and above the E layer. This implies that there must be two different types of particle. These are the evaporated meteors and the unevaporated meteors. Meteor effects are exaggerated on high frequencies.

(3) The inadequacy of the explanation of height constancy obtained geometrically when the line from the transmitter cuts the meteor orbit at right-angles. The height constancy is a definite consequence of my theory of scatter clouds, and is produced by the range of penetration of the molecules from the particles evaporated. In the Dellinger fade theory, it depends upon the range of the photo-electrons.

(4) The effect of wave-length. The wave-length effect can best be understood by referring to the mathematical form of the intensity of the waves scattered from a cloud. This is:

$$\delta\nu^2 (\lambda/a)^4 \exp\{-f(h)\},$$

where ν is the critical frequency corresponding to the density of the cloud, a is the radius of the cloud, and $f(h)$ is a function of the height of the cloud above the earth.

This has three factors, which show that the biggest effect is produced by a large number of particles, that the wave-length λ reduces the effect at a given height in proportion to λ^4, and that there is an attenuation factor which is dominant. This attenuation factor has much more effect than the λ factor, and we got observations when the attenuation is small and the λ^4 factor does not matter so much.

Observations show that the only wave-lengths on which scatter clouds are wholly associated with meteors, and not with Dellinger fades, are the short ones. On all others they may equally well be associated with either. A comparison between the results of long-wave and short-wave experiments is interesting.

My picture is this: Meteor clouds and meteors penetrate rather deeply into the atmosphere and can only be observed when the attenuation factor is small, that is, when sufficiently high frequencies are used. The result is that sufficiently short radio waves select the meteor-produced clouds. Those produced at a constant height, as in Dellinger fade effects, are not selected, and require long waves to disclose them.

Fig. 14 in my paper referred to earlier[2] shows that the field scattered from a cloud is proportional to λ^4. This is a complete experimental confirmation of the theory of scatter clouds.

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[1] *Nature*, **161**, 278 (1948).

[2] *J. Inst. Elect. Eng.*, **86**, No. 522, 548 (June 1940).

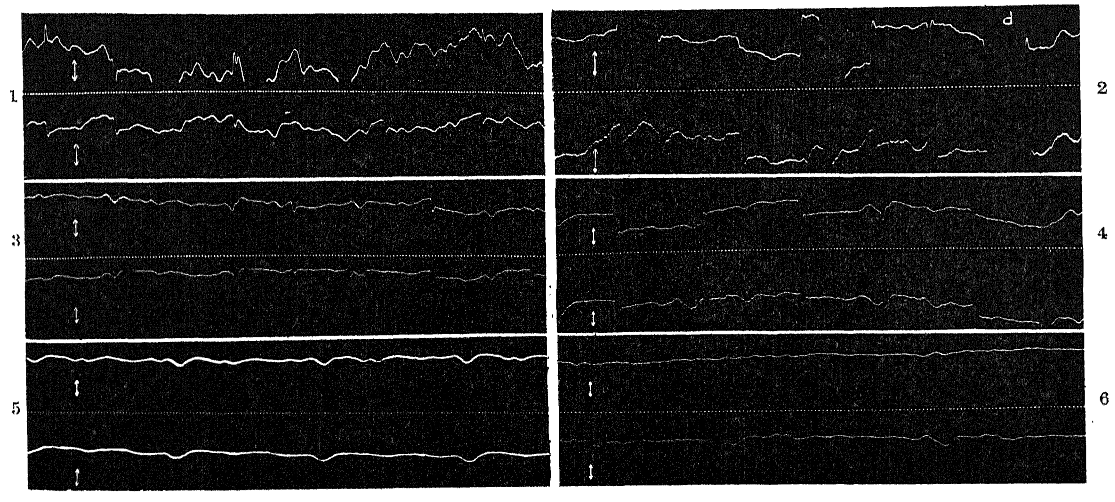
[3] *Nature*, **160**, 91 (1947).

Eye Movements During Monocular Fixation

A method of recording small eye movements during monocular fixation has been described by one of us[1], in which a beam of ultra-violet radiation (λ = 3650 A.) is incident on the cornea in such a direction that the fraction of the light transmitted through the cornea falls on the subject's blind spot when some test object is fixated by the illuminated eye; the subject is then, in effect, only aware of the fixation target. Part of the radiation, however, is reflected at the cornea; this reflected beam strikes a half-aluminized mirror and is there divided so that one part falls on a vertical straight edge and the other on a horizontal one. In each case, more or less of the radiation passes the straight edge as the eye moves, the fraction passed being focused on to an electron multiplier photocell. The output of each multiplier is amplified and fed to a cathode ray oscillograph, the time base of which is suppressed. The two oscillograph beams are in this way arranged to give vertical traces only, which are photographed simultaneously on a continuously moving film travelling in the horizontal direction. The eye movements can then be deduced from the two records on the film. The system is sufficiently sensitive to detect eye movements of 1 minute of arc; deflexions due to noise from the multipliers do not, in general, correspond to more than half a minute of arc.

To reduce head movements, the subject is placed in the prone position with the head resting on a firm foundation and partially supported in a sling. He also bites on a dental impression mouthpiece suspended above him from an adjustable mounting. Slight head movements, however, persist; their effect on the corneal reflex, apart from compensating eye movements, was first found by recording the reflexion from an artificial cornea supported on a spectacle frame just above the live cornea. Afterwards, a more rigid attachment of the artificial cornea to the skull was obtained by mounting it on an aluminium strip, the other end of which was fixed to a dental regulation band clamped round one of the front teeth of the upper jaw. This method, however, presents difficulties in the case of observers with closely set teeth.

Head movement records for W. D. W. are shown in Fig. 1, as obtained by the tooth attachment method. The movements are seen to be periodic and are evidently related to the beating of the heart. The longitudinal movements are appreciably greater than the sideways displacement; but, even so, the greatest movement shown in the record corresponds to a displacement of the head of only 0·01 mm. Subject M. P. L. was unable to use the tooth attachment, but her steadiest eye movement records show



1. Head movements of W. D. W. 2. Head movements of M. P. L. (derived). 3 and 5. Eye movements of W. D. W. Fixation target, bright spot angular diameter 3 minutes. 4 and 6. Eye movements M. P. L. Fixation target, bright cross, angular width arm 1 minute, angular length arm 20 minutes. Time marked by dots, 50 per second. Amplitude shown at side; height of arrowed line represents 10 minutes of arc. Upper record gives eye movements in vertical plane, lower record in horizontal plane

a periodicity similar to that occurring in the head movement records of W. D. W. From a study of several of her steadiest records, it was thus possible to deduce her head movements indirectly, as shown in Fig. 2.

Records 3 and 4 show typical eye movements for each subject during monocular fixation, when the subject was at his steadiest. The main feature which distinguishes the eye movements from the head movements is the rapid flick lasting 0·02–0·03 sec. and indicating a momentary angular movement of the eye of amplitude ranging from about 3 to 14 minutes of arc, and an average frequency of about 2 per sec. for W. D. W. and 3 every 2 sec. for M. P. L.

Between these flicks most of the recorded movement could be attributed to head movements, although in the absence of simultaneous head and eye movement records this is not certain. After each flick, the records suggest that the eye may take up a slightly different fixation direction displaced some few minutes of arc from the previous direction. This effect might be due to slight irregularities building up on the corneal surface; however, after-image experiments, for example, observation of the after-image of a bright annulus during fixation of a point source of light, seem to confirm the first interpretation.

On the majority of occasions, however, it was impossible to obtain records as steady as those in Figs. 3 and 4, random eye movements of 10 or 20 minutes of arc commonly occurring, as shown in Figs. 5 and 6. The gap at P in record 5 is due to a blink and indicates obstruction at the centre of the cornea lasting for 0·2 sec., in general agreement with data presented recently by Lawson[2]; in this, as in most cases, little subsequent disturbance in fixation direction has been produced.

Tests made with various fixation targets showed no significant variation in fixation ability, relative to the day-to-day variation in ability to fixate on a given target. There is little evidence of any fine vibratory movements having a period of the order of 0·02 sec. as reported by Adler and Fliegelman[3] and discussed at length by Jones and Higgins[4] in connexion with the resolving power of the eye.

We wish to acknowledge with thanks the financial support of the Medical Research Council in this work, and also the help of Mr. J. Baird in connexion with the dental regulation band.

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[1] Lord, *Proc. Phys. Soc.* (in course of publication).

[2] Lawson, *Nature*, **161**, 154 (1948).

[3] Adler and Fliegelman, *Arch. Ophthalmol.*, **12**, 475 (1934).

[4] Jones and Higgins, *J. Opt. Soc. Amer.*, **37**, 217 (1947).

The Fundamental Colour Sensations

IF pressure, sufficient to be thoroughly uncomfortable, is maintained by the fingers on the eyeball, numerous violet dots will eventually appear in among the other entoptical phenomena. Each dot lasts a second or so. If the pressure is suddenly released, all the entoptical phenomena disappear except the violet dots, which are left for a few seconds against a dark background. They are fairly uniformly distributed over the field of view, and may number anything up to, say, 100. From the fact that all the violet dots are of exactly the same hue, saturation and intensity and of approximately the same size, one is probably justified in assuming that they are the fundamental violet sensation. By looking at a spectrum with the other eye (light-adapted) it is possible to match their hue against a spectral hue. They match 440·5 mμ, the standard deviation of each observation being ± 5 mμ and that of the mean being ± 0·5 mμ. They are considerably more saturated in colour than spectral violet. Their apparent angular diameters are of the order of 10′. From the tritanopic isocolour chart given by Pitt[1], which depends on a description by König of five pathological cases of tritanopia, one can deduce that the fundamental violet sensation is equivalent to the sensation produced by 435 mμ, except that it is more saturated. Considering the inadequacy of the data available to Pitt, the discrepancy between 440·5 mμ and 435 mμ is not significant.

Gentler pressure will, in suitable circumstances, produce a uniform green colour of low intensity throughout the field of view. If one continues with this pressure for a minute or so, a green patch of greater luminosity but of about the same saturation appears, usually in the temporal field. By suitable adjustment of the pressure, it may be made to grow into a broad elliptical halo surrounding the macula, which by comparison looks black. The horizontal axes of the halo are about 1·3 times the vertical, the inside horizontal axis subtending about 7° and the outside about 30°. Both measurements are very variable, and occasionally the hole in the centre of the halo is green and is surrounded by darkness. The halo is slightly more saturated than any spectral green and matches 555 mμ, the standard deviation of each observation being 3 mμ and that of the mean being 0·7 mμ. This does not agree with the value 505 mμ obtained from Pitt's colour triangle for the hue of the green fundamental sensation, nor is it sufficiently saturated. It seems, indeed, to be a most improbable value for a fundamental sensation on any trichromatic theory which disallows negative stimulation. As the halo gets fainter, it appears to become slightly bluer in the same way as spectral 555 mμ does, but it is doubtful whether it ever becomes as blue as 505 mμ. Hence, in terms of trichromatic theory, it is probably a mixture in fairly constant proportions of the red and the green fundamental sensations only.

Reddish spots can also be made to appear. They are apparently of two or more different kinds, the smallest being very much smaller than the violet dots. All types are so fleeting that it is difficult to match them against the spectrum, or even to see whether they are alike.

No colourless entoptical phenomena appear as a consequence of pressure. This result and the occurrence of the violet dots at approximately the position in the colour triangle predicted by Pitt are rather more readily explained on classical trichromatic theory than on Granit's[2] theory of dominators and modulators.

All the above results were obtained on one observer (male) with normal colour vision.

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[1] *Proc. Roy. Soc.*, B, **132**, 101 (1945); chart on p. 107 wrongly labelled protanopic.

[2] "Sensory Mechanisms of the Retina" (Oxford Univ. Press).

Basque Blood Groups

We have determined the full *ABO*, *Rh* and *MN* blood groups of 167 Basques. The persons examined were selected as being of unmixed Basque descent, mostly by the Rev. Prof. J. M. de Barandiaran. None of the persons examined was known to be a blood relation of any of the others. The accompanying tables give a summary of our results.

ABO Groups

Group	Number	Frequency observed	Frequency expected	Gene frequencies
O	85	0·5090	0·5071	A_1 0·2343
A_1	67	0·4012	0·4002	A_2 0·0248
A_2	6	0·0359	0·0359	B 0·0288
B	7	0·0419	0·0418	O 0·7121
A_1B	2	0·0120	0·0135	
A_2B	0	0·0000	0·0014	
	167	1·0000	0·9999	1·0000

MN Groups

Group	Number	Frequency observed	Frequency expected	Gene frequencies
M	55	0·3293	0·3068	M 0·5539
MN	75	0·4491	0,4942	
N	37	0·2216	0·1990	N 0·4461
	167	1·0000	1·0000	1·0000

Rh Groups

Rh phenotype frequencies

Reactions with antisera Anti–					Commonest genotype in each phenotype	Number	Frequency observed	Frequency expected
C	D	E	c	e				
−	−	−	+	+	cde/cde (rr)	48	0·2874	0·3275
+	+	−	+	+	CDe/cde (R_1r)	79	0·4731	0·3904
+	+	−	−	+	CDe/CDe (R_1R_1)	13	0·0778	0·1246
−	+	+	+	+	cDE/cde (R_2r)	13	0·0778	0·0795
+	+	+	+	+	CDe/cDE (R_1R_2)	10	0·0599	0·0487
+	−	−	+	+	Cde/cde ($R'r$)	3	0·0180	0·0180
−	+	−	+	+	cDe/cde (R_0r)	1	0·0060	0·0064
−	+	+	+	−	cDE/cDE (R_2R_2)	0	0·0000	0·0047
+	−	−	−	+	Cde/Cde ($R'R'$)	0	0·0000	0·0002
						167	1·0000	1·0000

Frequencies of gene combinations

cde	(r)	0·5723
CDe	(R_1)	0·3376
cDE	(R_2)	0·0688
Cde	(R')	0·0157
cDe	(R_0)	0·0056
cdE	(R'')	0·0000
		1·0000

The high frequency of *Rh*-negative (*D*-negative) persons (30·5 per cent) and of the *d* gene (58·8 per cent) are in agreement with the findings of Etcheverry[1] and support the views recently put forward by one of us[2] regarding the history of the *d* gene. The low frequency of *cDE* is another notable feature. The excess of *Dd* heterozygotes and the deficiency of *MN* heterozygotes are clearly due to unavoidable errors of sampling. For this and other reasons steps are being taken to examine more persons. The combined results and a full discussion of them will be published elsewhere.

We should like to thank Prof. de Barandiaran and the members of the Basque delegations in London, Paris and Bayonne for their highly efficient organisation which alone made the collection of the specimens possible. One of us (J. N. M. C.) is in receipt of a Government Grant for Scientific Investigation through the Royal Society, and a grant from the Slater Fund at St. George's Hospital Medical School.

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Evolution of Hydrogen from Ferrous Hydroxide

It is generally supposed that ferrous hydroxide in aqueous suspension can decompose, according to the equation

$$3Fe(OH)_2 = Fe_3O_4 + 2H_2O + H_2.$$

The experiments of Schikorr[1] suggest that this can occur, but only in presence of metallic iron or excess of ferrous salt in solution.

The matter is important in connexion with the attack of iron by pure oxygen-free water. Warner[2] showed that a reaction such as

$$Fe + 2H_2O = Fe(OH)_2 + H_2$$

is permissible on grounds of energy; it might, however, be precluded on grounds of geometry if a continuous film of ferrous hydroxide were built up, separating the iron from the water. Possibly this protection might fail if the hydroxide were converted to anhydrous magnetite (a denser substance, commonly produced in granular form).

Actually, Murata[3] found that oxygen-free water acting on iron powder evolved hydrogen for a month, yielding ferrous hydroxide crystals; but Thompson[4], also using iron powder, reported the formation of magnetite on the glass apparatus; Corey and Finnegan[5], starting from iron rods, obtained non-adherent magnetite. Gould[6], working in this laboratory, observed no granular magnetite when water at the boiling point acted on steel with exclusion of oxygen; hydrogen was evolved at first, but attack soon became negligible, evidently owing to the formation of a protective film. In other experiments, where oxygen was intentionally admitted, a mass of magnetite and rust was found adhering to the metal at a few points only; it was probably formed by secondary oxidation of the ferrous hydroxide, mainly at a distance from the metal; its removal revealed deep corrosion-grooving. There is no necessary inconsistency between these various results, but it is clearly important to decide under what conditions Schikorr's reaction can occur; hence some new experiments have been carried out.

Ferrous hydroxide, pure enough to be almost colourless, was precipitated by mixing ferrous chloride and potassium hydroxide solution in an atmosphere of hydrogen. These solutions were prepared by the electrolysis of a de-aerated potassium chloride solution between a platinum cathode and a pure iron anode; the design of the apparatus was such that premature mixing of anodic and cathodic products did not occur and that the two solutions could be mixed in any desired proportions. The de-aeration was carried out by boiling followed by the passage of hydrogen through the solution. After precipitation, the ferrous hydroxide and supernatant liquid were left in a flask connected to a manometer, so that any evolution of hydrogen might be detected by a pressure increase. No hydrogen evolution was detected under these conditions, even with ferrous chloride in excess.

Further experiments were then performed, following more closely those of Schikorr[1]. Here the ferrous hydroxide was prepared by precipitation from a ferrous sulphate solution with sodium hydroxide. Under these conditions Schikorr reported evolution of hydrogen at room temperature, when ferrous sulphate was in excess, but not when alkali was in excess. However, in our experiments, no evolution of hydrogen was observed even when the reactants were heated to 100° C.

It was nevertheless found that hydrogen was evolved at room temperature, in the presence of excess ferrous sulphate, if certain additions were made to the solution before precipitation with alkali. These additions included platinum chloride, colloidal platinum, nickel sulphate, nickel powder and copper powder. A smaller evolution was also produced by the addition of sodium sulphide. It is as yet uncertain whether these metals themselves or their ions in solution are the true catalysts, and no views on the mechanism of the reaction are here offered.

No hydrogen has yet been obtained after the addition of manganese sulphate—a matter of obvious importance in connexion with steel.

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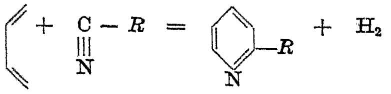
Reaction of Cyanogen and Related Compounds with Butadiene

Cyanogen and butadiene have been found to react at moderately high temperatures (400°–700° C.), forming as the main product 2-cyanopyridine. It has also been established that this behaviour of cyanogen may be generalized for the simple 1,3-dienes[1,2].

The present communication presents the results of some calculations and experiments with nitriles of the type R—CN, where R is H,CH_3,C_6H_5, as well as CN. In each case, the free-energy change for the reaction :


(1)

has been calculated over a range of temperatures in order to obtain information useful as a guide in the experimental investigation. These results are summarized in Table 1. The thermodynamic functions for 2-methylpyridine, 2-cyanopyridine and benzonitrile were calculated statistically, the vibrational frequencies of these compounds being assigned on a semi-empirical basis involving a consideration of the assignment for pyridine and benzene, and also the frequencies associated with the vibrations of the methyl and cyano groups. The functions for 2-phenylpyridine were estimated by a method of increments from the functions of 2-methylpyridine and benzene.

TABLE 1

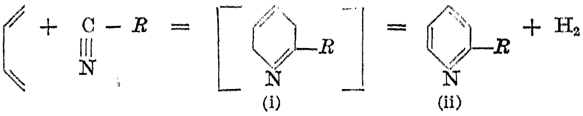
Reaction 1 with R as :	Product	ΔF (kcal.) for the reaction			
		T° K. 400	600	800	1000
H	Pyridine	−23·9	−20·9	−17·8	−14·7
CH_3	2-Methylpyridine	−18·9	−14·5	−11·1	−4·66
C_6H_5	2-Phenylpyridine	− 7·07	−5·37	−4·05	−3·05
CN	2-Cyanopyridine	−30·1	−27·2	−25·6	−20·6

It is seen that the calculated free-energy change is quite favourable over the temperature range in question in each case ; but since these results refer to equilibrium in ideal gaseous systems, a quantitative correlation with the experimental work has not been attempted. In Table 2 the data for three comparable vapour-phase experiments are given. The experiments were carried out at atmospheric pressure in an unpacked quartz reaction vessel, using continuous flow technique. The product in each case was identified by its known physical constants, and the melting point and analysis of the picrate. The yields are calculated on the amount of nitrile converted.

TABLE 2

Reaction 1 with R as :	Product	Temp. °C.	Contact time	Mol. ratio RCN/C_4H_6	Yield of product
H	Pyridine	595±5°	30 sec.	1·1/1·0	5–6 %
CH_3	2-Methylpyridine	599±5°	30 ,,	1·7/1·0	5–6 ,,
C_6H_5	2-Phenylpyridine	591±5°	31 ,,	1·7/1·0	12–16 ,,

These reactions may be explained as proceeding by a Diels – Alder mechanism in which the (—C≡N) has the role of the dienophilic component of the dienophile :



The intermediate (i) has not been observed among the products, and it would seem that it undergoes spontaneous dehydrogenation at these temperatures to form the thermodynamically more stable pyridinic product (ii).

A fuller account of this work is to be published elsewhere. The investigation is being continued.

We wish to thank Prof. C. K. Ingold and Dr. Albert Wasserman for helpful discussions, and Imperial Chemical Industries, Ltd., for some of the chemicals necessary for this investigation.

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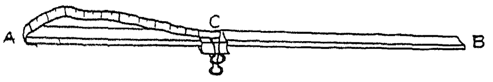
Rapid R_F Measurement in Chromatography

THE device described here has proved very useful for the rapid measurement of R_F values on paper partition chromatograms[1]. In the figure, *AB* is an aluminium strip 20 in. × ½ in. × ⅛ in., *AC* is a piece of white elastic 9 in. × ½ in. attached to the end *A* of the strip by sewing through a hole in the strip. The other end of the elastic *C* is attached to a small 'bulldog' clip. A scale (divided into 100 parts) is marked on the elastic. For use, the zero of the scale is placed at the origin line or spot and the 100 mark stretched out to coincide with the position reached by the solvent front. The R_F values of the spots can then be read off directly on the scale. While α-amino-acids can be recognized simply from their relative positions on a chromatogram, the device allows a quick check on isolated or unknown spots or the spread of a spot. A smaller apparatus on the same expanding-scale principle can be used for measuring the *R* value[2] of substances on a column where the ratio, movement of band/movement of sample of liquid in unpacked part of the column above, is employed.



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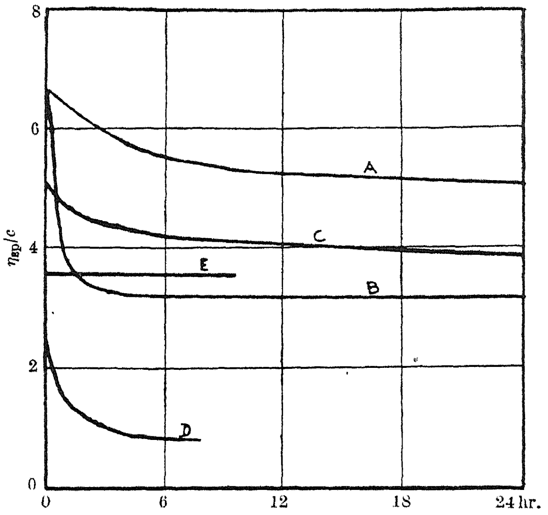
Degradation of a Vinylidene Chloride Copolymer in Solution

SOME observations have recently been made on the changes in viscosity of solutions of a copolymer containing approximately 85 per cent vinylidene chloride, 13 per cent vinyl chloride and 2 per cent acrylonitrile (by weight). The polymer was soluble in hot, but not in cold, tetrahydrofuran: once it had been dissolved by heating in the solvent at 60–65° C. for 2–3 min., the solution could be cooled to room temperature without gelling or precipitation.

Copolymer solutions of different concentrations, made up in redistilled tetrahydrofuran by heating as above, were aged in sealed glass tubes in contact with air for varying times at 50° C. and 75° C. Typical curves showing the changes in η_{sp}/c (where η_{sp} is specific viscosity and c is concentration in monomoles per litre) of the solutions with time are reproduced herewith (Curve *A*, 50° C., Curve *B*, 75° C.).

Investigation showed that the tetrahydrofuran used contained peroxides, and further work showed that: (*a*) a similar fall in η_{sp}/c was observed in cyclohexanone at 75° C., and in dioxane at 85° C., both in air (Curves *C* and *D*); (*b*) a slight reduction in η_{sp}/c took place in *peroxide-free* tetrahydrofuran at 75° C. in air; (*c*) little or no reduction in η_{sp}/c took place in *peroxide-free* tetrahydrofuran at 75° C. in nitrogen; (*d*) no reduction in η_{sp}/c took place in *o*-dichlorbenzene at 130° C. in air (Curve *E*).



AGEING OF VINYLIDENE CHLORIDE COPOLYMER SOLUTIONS

A. In tetrahydrofuran at 50° C.
B. ,, ,, ,, 75° C.
C. ,, cyclohexanone ,, 75° C.
D. ,, dioxane ,, 85° C.
E. ,, *o*-dichlorbenzene ,, 130° C.

These observations are consistent with the view that the viscosity decrease in these polymer solutions is due to a degradative attack on the long-chain molecules, not by oxygen directly, but by peroxides formed from the solvent and atmospheric oxygen. Tetrahydrofuran, cyclohexanone and dioxane are all known to peroxidize in the presence of oxygen (presumably with the formation of hydroperoxides at the carbon atoms adjacent to the ether oxygen or carbonyl group), while *o*-dichlorbenzene would not be subject to such an attack. Degradation of this type has previously been found to occur in the presence of oxygen[1–5], but the role of the solvent does not appear to have been appreciated.

That the changes in viscosity are most likely to be caused by polymer chain scission, rather than by any physical changes in the solution (breakdown of polymer aggregates, solvation[6], etc.) is also indicated by the fact that copolymer from a solution in tetrahydrofuran aged at 75° C. for 5 hr. (isolated by precipitation, washing and drying) could readily be redissolved in tetrahydrofuran at 25° C. to give solutions of η_{sp}/c identical with that of the *aged* solutions. Further, calculations of the approximate overall activation energy of the process, based on rates of change in η_{sp}/c of a solution in tetrahydrofuran at 50° C. and 75° C., gave a value of about 24 kcal. Neither of these observations is conclusive in itself, but taken in conjunction with the results already quoted, they inevitably suggest that primary valency bonds are being broken.

Sufficient evidence is not yet available for a discussion of the mechanism of this degradation, but a study of the rate of change of peroxide content in tetrahydrofuran, in contact with air, both with and without dissolved copolymer, has given some indication that the initial attack on the polymer may be by a radical produced during solvent autoxidation reaction[5], or by hydroperoxide fission.

The number of points in the copolymer molecule at which attack is possible may be limited, because copolymer isolated from solutions which have been aged to constant η_{sp}/c value at a particular temperature, when redissolved in fresh solvent containing peroxide, undergoes little or no further change when aged at the same temperature.

One of the objects of publishing these results is to direct attention to the possibility of error arising during viscosity and other measurements performed on solutions of polymers in solvents able to form peroxides by autoxidation. Detailed results will be published elsewhere at a later date.

We acknowledge helpful discussions with Dr. H. P. Staudinger and Mr. C. E. Hollis in the course of this work.

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Trichothecin: an Antifungal Metabolic Product of *Trichothecium roseum* Link

ANTAGONISTIC activity to other fungi by *Trichothecium roseum* Link (syn. *Cephalothecium roseum* Corda) has been reported by Whetzel[1], Boning[2], Koch[3] and Greaney and Machacek[4]. Culture filtrates of *T. roseum* have been shown to inhibit germination of *Botrytis allii* conidia[5]. We have isolated the substance responsible for this activity in crystalline form in yields of 20–30 mgm. per litre of culture filtrate. The name 'trichothecin' is suggested for the active substance.

The most satisfactory yields have been obtained by growth of the fungus for a period of 28 days at 25° C. on a modified Czapek-Dox medium, in which sodium nitrate was replaced by the equivalent quantity of ammonium tartrate. The medium contained 5 per cent of glucose and was supplemented by the addition of 1 per cent of corn-steep liquor. The development of antifungal activity was followed by means of a spore-germination assay using *Penicillium digitatum* conidia. Maximum concentration of trichothecin (40–50 mgm./l.) was attained after about 28 days.

Trichothecin was extracted from the culture filtrate with ether or chloroform and purified by chromatographic methods on activated alumina. It was finally recrystallized from light petroleum (b.p. 60–80°) and formed long, slender, colourless needles, m.p. 118°, which were optically active $[\alpha]_D^{18}$ + 44° (*c*, 1 in chloroform). It contains neither halogens, sulphur nor nitrogen. Microanalyses (Weiler and Strauss), found: C = 68·5, 68·7, 68·8 per cent; H = 7·2, 7·3, 7·4 per cent; mol. wt. (Rast) = 278. $C_{15}H_{20}O_4$ requires: C = 68·2 per cent; H = 7·5 per cent; mol. wt. = 264. $C_{15}H_{18}O_4$ requires: C = 68·7 per cent; H = 6·9 per cent; mol. wt. = 262. The compound is neutral and only slightly soluble in water (*c*. 400 mgm./l. at 25°) but readily soluble in most organic solvents. The molecule contains one ketonic group and one ethylenic group. These observations are supported by the ultra-violet absorption spectrum of trichothecin, which also suggests that the two groups are conjugated. No other functional groups have been detected. Methyl attached to carbon determination (Weiler and Strauss), found: $(C)CH_3$ = 16·4 per cent; 3 × $(C)CH_3$ groups require 17·0 per cent. There is no evidence of an aromatic nucleus.

At a concentration of 400 mgm./l. and *p*H 7·0, trichothecin was inactive against *Staph. aureus*, *B. subtilis* and *Bact. coli*. Its antifungal activity is exhibited against Fungi Imperfecti, Zygomycetes and Ascomycetes. The growth of each of some twenty-five species belonging to the above classes was inhibited to a greater or lesser degree. *P. digitatum* is the most sensitive species so far examined; germination of conidia was completely inhibited by 1·25 mgm./l. of trichothecin, and 50 per cent germination took place at a concentration of 0·30 mgm./l. The corresponding data for *Botrytis allii* spores are 6·25 and 3·12 mgm./l. Growth of the following fungi on beer wort agar was completely suppressed by the trichothecin concentrations given in parentheses: *P. digitatum* (0·64 mgm./l.), *Fusarium graminearum* (16 mgm./l.), *Paecilomyces varioti* (80 mgm./l.), *Saccharomyces carlsbergensis* (16 mgm./l.), and *Mucor erectus* (80 mgm./l.). *T. roseum* showed a partial reduction of growth at a concentration of 80 mgm./l.

Aqueous solutions of trichothecin were stable at *p*H 1 to *p*H 10 for at least 48 hours at 20°. At *p*H 12 the antifungal activity was rapidly destroyed even at room temperature. Aqueous solutions at *p*H 7 were maintained for at least one hour at 100° without detectable loss of activity.

Full accounts of the preparation and chemical and biological properties of trichothecin will be given elsewhere.

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Role of the *Y*-Chromosome in the Determination of Cell-size in *D. melanogaster*

I have already pointed out[1] that in wild stocks of *D. melanogaster*, Gaiano (Parma), Luino (Varese), Civate (Como), the unicellular hairs of the upper wing surface, counted in a standard surface of 298 μ^2 for each wing, show frequency differences. Furthermore, there are sex differences of different kinds in the three stocks, being highest in Gaiano, intermediate in Civate and lowest in Luino. This shows the possibility of an action of the *Y*-chromosome, already proved by Mather[2] for the chætæ also in *D. melanogaster*.

For this purpose I considered the Oregon *R* stock, which showed a very strong sex difference in addition to another cell character, namely, the eye corneolæ. The surface was measured directly[3] in ten ommatidia of one eye (either the right or the left one, both being significantly similar) in each individual, and the mean was calculated. (The complex of the corneolæ of one eye was prepared after treatment in potassium hydroxide of the entire eye, and mounted in glycerine; the wings also were mounted in glycerine.) The following figures are the mean for thirty flies; the standard errors are indicated.

Oregon *R*:	*hairs*	♀ $16{\cdot}06 \pm 0{\cdot}58$	♂ $20{\cdot}60 \pm 0{\cdot}60$	Diff. 22·50% (significant)
	corneolæ	♀ $847 \pm 20{\cdot}7\mu^2$	♂ $732 \pm 14{\cdot}9\mu^2$	Diff. 13·70% (significant)
Luino:	*hairs*	♀ $21{\cdot}25 \pm 0{\cdot}28$	♂ $21{\cdot}83 \pm 0{\cdot}75$	Diff. 2·70% (not significant)
	corneolæ	♀ $681 \pm 30{\cdot}0\mu^2$	♂ $697 \pm 29{\cdot}0\mu^2$	Diff. 2·30% (not significant)
Gaiano:	*hairs*	♀ $15{\cdot}61 \pm 0{\cdot}24$	♂ $17{\cdot}43 \pm 0{\cdot}57$	Diff. 10·45% (significant)
	corneolæ	♀ $732 \pm 15{\cdot}30\mu^2$	♂ $689 \pm 20{\cdot}05\mu^2$	Diff. 5·90% (not significant)

The sex differences of the hair frequencies tested with Fisher's Z test are significant for Oregon and Gaiano, but not for Luino. The corneolæ are significantly different only in Oregon. Males from Luino and Gaiano were mated successively to Oregon females and the heterozygous males back-crossed to Oregon females for six subsequent generations, in order to make the stocks isogenic; they become in this manner 'oregonized', except for the Y-chromosome, if no crossing-over between X and Y occurred.

This procedure was repeated twice, and every factor of the environment capable of inducing phenotypical variations (food, temperature, bottle volume, number of flies) was kept constant.

The mean values for both independently 'oregonized' stocks of Luino obtained from thirty individuals for each sex are:

Hairs	♀	(I) $17{\cdot}70 \pm 0{\cdot}59$	♂	(I) $18{\cdot}50 \pm 0{\cdot}51$	Diff. not significant
		(II) $17{\cdot}40 \pm 0{\cdot}29$		(II) $17{\cdot}80 \pm 0{\cdot}36$	,, ,, ,,
Corneolæ	♀	(I) $830 \pm 19{\cdot}0\mu^2$	♂	(I) $801 \pm 19{\cdot}0\mu^2$	,, ,, ,,
		(II) $783 \pm 14{\cdot}7\mu^2$		(II) $744 \pm 16{\cdot}7\mu^2$	,, ,, ,,

The results for Gaiano are intermediate between Oregon and Luino, also after the 'oregonization'. It is interesting that the sex difference for the corneolæ (♀ 847 ± 26; ♂ 744 ± 45) of Gaiano is significant in this stock only after 'oregonization'. Both characters were measured in subsequent 'oregonized' generations, and only insignificant differences were found.

The data may be summarized as follows. Both characters are similarly influenced by the Y-chromosome, because the amount of the sex difference remains of the same order of magnitude, even when the euchromatin has been profoundly rearranged by the crosses. The Y-chromosomes of Oregon and Gaiano make the cells of the females larger, whereas the Y-chromosome of Luino does not induce any appreciable difference. On the other hand, the values obtained before and after 'oregonization' are different, and both characters in Luino are nearer to the Oregon ones in the latter stage. This proves the participation of the euchromatic chromosomes in the determination of the cell size.

These results agree with those obtained by Mather, and make it possible to go further in the functional interpretation of the heterochromatin. Actually, owing to the type of the characters considered, a connexion is established between the Y-chromosome and cell size, that is, between heterochromatin and cellular growth. This connexion is the same as that pointed out by Caspersson[3] using a quite different method. In fact, my experiments prove genetically that heterochromatin has a role of the same kind as direct observations of the cellular polynucleotides permit one to infer[4].

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Seaweed Culture

Comprehensive culture experiments of algal spores and ova have been carried out, and still more are in operation as part of the programme of research of the Scottish Seaweed Research Association. The principal object of this work is to ascertain the minimum requirements for the development and healthy growth of zoospores and zygotes of the brown algæ, yet at the same time departing as little as possible from natural conditions.

In the last experiment to be completed, zoospores of *Laminaria Cloustoni* were added to thirty small tanks containing either natural or artificial sea water, well aerated and circulated. Additional nutrients were dissolved in some tanks, light restricted in others, water remained unchanged in some cases and changed in others.

Among the many interesting results, it was found that the zoospores showed their greatest development when disodium hydrogen phosphate, sodium nitrate and sodium bicarbonate were added in combination to natural sea water unchanged during the experiment. Two embryo sphorophytes, which have developed from the zoospore through the gametophyte to the sporophyte stages in the above solution in 28 days, are shown in Fig. 1. Up to 32-cell stages were found after 36 days.

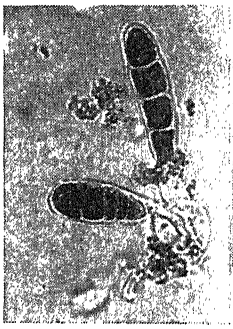

Fig. 1

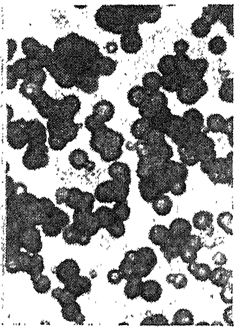

Fig. 2

Fig. 1. Sporophyte embryos of *Laminaria Cloustoni*. 28 days in sea water with added phosphate, nitrate and bicarbonate. × 350

Fig. 2. Development of *Laminaria Cloustoni* zoospores in sea water with added uranium nitrate. × 350

The surprising result of zoospore development of *L. Cloustoni* during the same experiments, when uranium nitrate was added to natural sea water unchanged during the experiment, is shown in Fig. 2. What was thought to be a precipitate of uranium proved to be a most prolific growth. More zoospores developed in this tank than in any of the others. The zoospores appear to have begun to develop into gametophytes at a rate far outstripping the normal. The nuclei in some cases have divided without subsequent development of the cell wall. The result is probably more 'cancerous than polyploid'. The nuclei are more conspicuous and take up a central position within the cell. The cell walls were hardened by the end of a month and the cells were killed at some time during this period, although their initial growth by division was stimulated. No living bacteria or protozoa were seen in this tank, although both were found active in most other tanks.

During the extensive seaweed survey of the Scottish coast[5] it was noticeable that the growth of Laminariæ was poor where *Ascophyllum nodosum* was abundant. It is also known that *A. nodosum* will ultimately dominate virgin substrata initially colonized by *Fucus vesiculosus*. The senior author has long considered it a probability that *A. nodosum* might exude something which inhibits the development of competitive algæ, and to test this, zoospores of *Laminaria Cloustoni* were grown in natural sea water with a piece of living, mature *A. nodosum*. The water of this particular tank was noticeably clearer than any of the others, and inspection after 28 days showed the zoospores to be completely decolorized. (Of the marine aquaria maintained in the laboratory, the water of one containing *A. nodosum* sporelings always remains the clearest.)

From this, three points emerge: (1) *A. nodosum* produces an antibiotic; (2) the effects of this antibiotic in decolorizing the chlorophyll serves a useful means for more easily studying the nuclei of *L. Cloustoni*, which unfortunately are structurally minute; and (3) is the zonation of the littoral Fucaceæ due to 'chemical claws'?

The nuclei of the normal spores, the spores grown with uranium nitrate and *A. nodosum* appear visually similar. They comprise two small stainable masses within a sac of clear material.

Full details will be published elsewhere with full bibliography.

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Growth of *Phytophthora infestans* (Mont.) de Bary on Artificial Media

IT appears from the literature on *Phytophthora infestans* that many workers have had difficulty in growing this fungus and in obtaining a supply of sporangia. The fungus grows and fructifies well on potato leaves and tuber slices, but such cultures require frequent renewal. Recently Snieszko *et al.*[1] in the United States described various media which supported growth, particularly a cereal grains – peanut hull mixture upon which the fungus spored freely. Peanut hulls are not readily available in Great Britain.

In this laboratory, media for the culturing of *P. infestans* have been made from germinated oats, wheat, maize and pea and from dried leaves of potato and tomato. At its best the dried potato leaf medium was much superior to all other materials tried. Sporulation was sometimes so abundant that cultures had a powdery rather than a downy appearance. Unfortunately, as with oat, wheat, maize and tomato, this medium was unreliable, often giving poor growth and sporulation. A reliable medium made from pea-flour has now been evolved. It is felt worth while to publish the information, although the method is by no means perfected.

This medium contains 2·5 per cent pea-flour, 2·5 per cent sucrose, 1 per cent agar and distilled water. The sucrose, agar and half the water are sterilized at 15 lb. pressure for 15 min., and to this is then added the pea-flour in the rest of the water heated to 40° C. After rapid and thorough mixing, the medium is tubed and plugged. The tubes are left at laboratory temperature for 18–24 hr., sterilized at 10 lb. pressure for 6 min. and sloped.

The pea-flour is made from garden peas grown in sand under glass. When the plants are 2–3 in. high, their leaves and stems are chopped up and dried on glass sheets in an electric oven at 55–60° C. The time taken for drying varies from two to three hours. The dried material is ground with a hand-mill and stored in screw-capped bottles in the dark.

This pea-flour medium has been in use for more than a year, and in no instance has the fungus failed to grow or sporulate on any batch of it. Some isolates of *P. infestans*, however, grow more rapidly and spore more freely than others. In test-tubes (6 in. by ⅝ in., 5 ml. medium) at 18° C. the fungus usually covers the agar in a week and sporing begins in two to three weeks. Sporulation is greater if the cultures are stored in closed jars. The danger of mould contamination arising from these damp conditions can be avoided by exposing the cultures once weekly to room humidity for a few hours and replacing them in clean, dry jars. If the fungus is grown in boiling tubes (7 in. by 1 in., 15 ml. medium), good sporulation will take place even if the cultures are not kept enclosed. It is advisable, however, to keep them in jars until the fungus is well established.

Some isolates of the fungus survive longer in culture than do others. Test-tube cultures kept at 18° C. require subculturing every four to five weeks; at 10° C. every ten to twelve weeks. In boiling tubes, some cultures have remained alive for as long as seventeen weeks, whereas others have lasted only ten to twelve weeks.

Spores produced by *P. infestans* on this pea-flour medium have infected potato seedlings, tubers and adult leaves. The effect of continuous cultivation on the pathogenicity of the fungus is under investigation.

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Hysteresis in the Swelling of Gels

HYGROSCOPIC natural fibres generally show sorption hysteresis, such that the vapour pressure at any given moisture content is higher on adsorption than on desorption, whereas no hysteresis is found in true solutions.

In 1942 I suggested[1] that sorption hysteresis in gels could be explained in terms of their plastic properties. This deduction is based on the fact that the vapour pressure of a gel is determined by the hydrostatic stress acting on it as well as by the moisture content. It can be shown[2] that, if either anatomical or molecular restraints oppose the free swelling and introduce plastic flow under shear stresses, the hydrostatic component p of the stress system, and therefore also the vapour pressure h, will be higher on adsorption than on desorption at any given moisture content m.

If, between adsorption and desorption, the difference in hydrostatic pressure is Δp, this must produce a change in volume of the gel: $\Delta V = -V\Delta p/k$, where k is the bulk modulus: while the value of

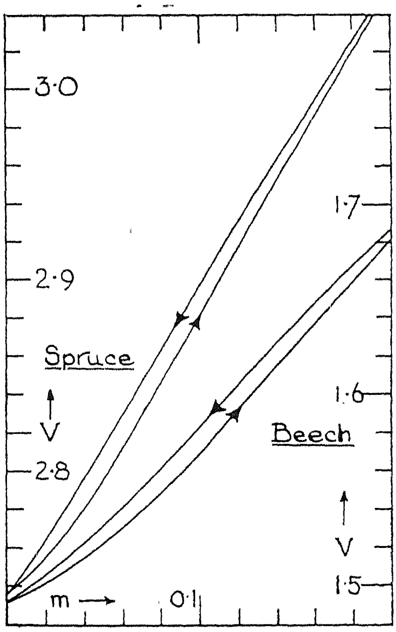
Units: $k = 10^{10} \times$ dynes/sq. cm.; V = c.c./gm. dry weight; m = gm. water/gm. dry weight.

	Solid fibres V (dry) = 0·0661 k 0·86		Spruce V (dry) = 2·731 (75·3% void space)				Beech V (dry) = 1·492 (54·8% void space)			
m	s_p	ΔV (calculated)	s_p	k	ΔV (calculated)	ΔV (observed)	p	k	ΔV (calculated)	ΔV (observed)
0·05	0·73	0·0045	1·58	2·55	0·020	0·016	0·833	3·37	0·0144	0·0081
0·10	0·90	0·0016	1·74	1·20	0·048	0·015	1·041	1·80	0·0253	0·0105
0·15	0·95	0·0008	1·62	0·70	0·054	0·008	1·087	1·05	0·0216	0·0119
0·20	0·98	0·0003	1·50	0·55	0·042	0·000	1·071	0·82	0·0185	0·0027

Δp can be obtained from the vapour pressures, h' on adsorption, and h'' on desorption, from the approximate relation $\Delta p = -(RT/Ms_p)\log(h'/h'')$, in which $s_p = (dV/dm)_p$ the differential volume swelling of the gel. Thus, if the origin of sorption hysteresis lies in plasticity, the volume swelling should show hysteresis if plotted against the moisture content, such that the volume will be smaller on adsorption than on desorption.

Calculations of ΔV can be compared with experiment by using the measurements of Hermans[3] on solid fibres of regenerated cellulose, or those on beech[4] and spruce, made in this Laboratory. Approximate values of k may be taken from calculations made here. In the case of the solid fibres these are incomplete, since the variation of k with m is not known and a single mean value must be used for all moisture contents.

The table gives these estimates of ΔV. For the solid fibres all values of ΔV (except at $m = 0·05$, where k is most in doubt) lie below the limit of accuracy claimed by Hermans (0·002 c.c./gm.) and will therefore not be detectable. This agrees with Hermans' own statement that no volume hysteresis is found. For spruce and beech the values of ΔV lie well above the limit of accuracy and a hysteresis of this order of magnitude is found experimentally, as can be seen in the accompanying graph.



So far as I am aware, this graph records the only experiments so far made which show volume hysteresis in the swelling of gels. This is no doubt because in most solid gels, such as Hermans', k is large and the hysteresis is too small for easy detection; whereas in porous gels such as wood, k is much smaller and the hysteresis therefore more prominent.

The above calculation has tacitly assumed that the gel is plastic to shear stresses and elastic to the hydrostatic stresses. It can be shown both by theory and experiment[2] that some plasticity to Δp occurs in complex porous structures such as wood, so that some relaxation in Δp is to be expected. This effect would be more marked at the higher moisture contents where the wood is more plastic, and would account for the observed fall in ΔV to very small values in this region.

A full discussion of this subject is given in an internal unpublished Laboratory report, No. P.82 (1948).

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Fine Structure of the He II Line λ = 4686 A.

According to the Dirac theory of the energy states in hydrogen-like spectra, levels of the same principal quantum number n which have the same value of the quantum number of total angular momentum j should coincide. Lamb and Retherford[1] have shown that in the second quantum state of the hydrogen atom the 2 $^2S_{1/2}$-level lies 0·03 cm.$^{-1}$ above the 2 $^2P_{1/2}$ term. Bethe[2] has tried to explain this discrepancy by an interaction of the electron with the radiation field. His preliminary calculations show complete agreement with experiment for the hydrogen atom. For the He II spectrum he predicts a shift of the 3 $^2S_{1/2}$-level with respect to the 3 $^2P_{1/2}$-level by 0·13 cm.$^{-1}$.

We have investigated the fine structure of the He II line $\lambda = 4686$ A. ($n = 4 \rightarrow n = 3$) with a Fabry-Perot interferometer and have found that the 3 $^2S_{1/2}$-level lies 0·137 ± 0·015 cm.$^{-1}$ above the value given by the Dirac theory. Greater accuracy has not yet been possible because of the breadth of the lines.

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THE CYTOLOGY OF THE HONEY BEE, *APIS MELLIFICA* L.

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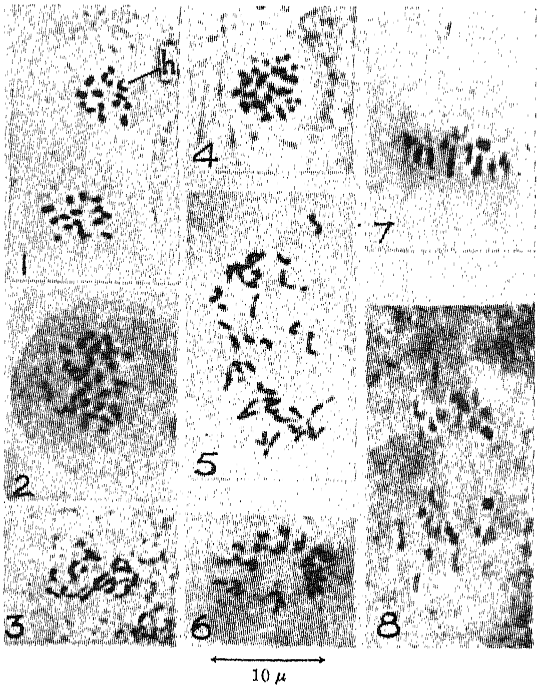
THE cytology of *Apis mellifica* L. has been investigated by Petrunkewitsch[1,2], Doncaster[3,4], Mark and Copeland[5], Meves[6], Nachtsheim[7,8], and Jegen[9]. Nachtsheim figures the chromosomes as spherical in shape, 16 in number in spermatocytes and oogonia, and reduced to 8 in the ootid. In his interpretation of the chromosome constitution of the male and female he resorts to a theory of "*Sammelchromosomen*", in which some chromosomes are said to be "*einwertig*" and others "*doppelwertig*". His cytological findings are so exceptional and the results of the workers mentioned above are so anomalous that they are open to criticism (see Sanderson[10]). Furthermore, on the basis of Nachtsheim's work, a theory that the drone bee is a diploid organism with a haploid germ tissue has been recently advanced by Whiting[11]. The problem obviously required re-investigation and this we have undertaken, using improved modern methods of fixation and of smear technique on abundant material.

The accompanying photographs of our material clearly show the chromosome number in male and female to be 16 and 32 respectively, and also the chromosomes to be mostly rod-shaped, not rounded as depicted by Meves, Doncaster and Nachtsheim.

Smears of larval testes fixed and stained in aceto-carmine or aceto-orcein yield convincing counts of gonial plates (Fig. 1). In these one chromosome is hooked and somewhat larger than the rest (Fig. 1, *h*); it is very striking in late anaphase. In oogonia two similar hooked chromosomes can be distinguished. These findings agree with the work of Granata[12,13] on the spermatogenesis of the carpenter bee, *Xylocopa violacea* L., where the 16 chromosomes are hooked and separate. In the honey bee we have never found the chromosomes lying in pairs in either male or female and we therefore suggest that the apparent pairing of chromosomes and formation of "*Sammelchromosomen*" found by Nachtsheim were due to the technique employed. Oogonial counts can be obtained from queen larvæ and pupæ (Fig. 4), and plates showing the same number, 32, can also be obtained from worker larvæ before the ovaries degenerate.

With regard to the abortive division of the spermatocytes, we confirm the observations of former workers that the chromosome number is not reduced during maturation, but we have not been able to confirm currently accepted views on bud formation.

Our investigation of egg maturation is still incomplete, but examination of some twenty spindles in smeared unfertilized eggs shows that maturation follows the usual method found in arrhenotokous saw-flies and other groups of insects. The first spindle lies near the margin in the broad end of the egg; in aceto-orcein squashes the chromosomes in metaphase and early anaphase appear to be viscous (Fig. 7); about 16 bivalents can be counted on the equator and, later, 16 chromosomes travel towards each end of the spindle; the daughter groups line up on two other spindles which appear to arise immediately, and some of these chromosomes already show chromatid formation (Fig. 8).



PHOTOGRAPHS OF MALE AND FEMALE TISSUES OF HONEY BEE, ALL TO SAME SCALE. FIG. 4 IS FROM A SERIAL SECTION STAINED WITH IRON HÆMATOXYLIN; ALL OTHERS FROM ACETO-ORCEIN SMEARS

Fig. 1. TWO SPERMATOGONIAL PLATES; 16 CHROMOSOMES; *h*, HOOKED CHROMOSOME

Fig. 2. DIPLOID PLATE IN MALE FOLLICLE CELL; 32 CHROMOSOMES

Fig. 3. MALE BLASTODERM CELL; ABOUT 16 CHROMOSOMES

Fig. 4. OOGONIUM; 27 CHROMOSOMES SHOWN

Fig. 5. FEMALE BLASTODERM CELL, LATE PROPHASE; ABOUT 32 CHROMOSOMES

Fig. 6. FEMALE BLASTODERM CELL, METAPHASE; 31 CHROMOSOMES SHOWN

Fig. 7. EGG MATURATION, FIRST SPINDLE METAPHASE; ABOUT 13 BIVALENTS IN FOCUS

Fig. 8. EGG, SECOND MATURATION SPINDLES; 15 CHROMOSOMES SHOWN IN LOWER METAPHASE PLATE, AND 15 CHROMOSOMES IN UPPER METAPHASE PLATE (3 DISPLACED TOP LEFT)

Regarding evidence of somatic numbers, male and female blastoderm smears distinctly show 16 and 32 (Figs. 3, 5 and 6), and here the chromosomes by comparison with those of germ cells are much longer and thinner, so that size differences are more apparent. Though further work is necessary, our material gives the impression that blood and muscle cells in the pupæ show normal numbers. Somatic polyploidy does occur in hypodermal, malpighian and tracheal cells, and follicular epithelium cells of testis and ovary. In the male, follicle cells with 32 (Fig. 2) or more commonly occur; in the female, follicle cells with the gonial number are rare, but the actual degree of polyploidy is not yet determined. Likewise, embryonic serosa cells frequently become polyploid. In contrast to the non-social Hymenoptera, where the male is conspicuously smaller than the female, the drone and queen honey bee do not show such disparity; the relation of body size to polyploidy in the bee therefore requires further investigation. It is also necessary to ascertain in what particular tissues polyploidy arises.

Our evidence establishes beyond doubt that the male is haploid, at least at the beginning of cleavage, in blastoderm stages and in the larval testis. Whiting, basing his theory on Nachtsheim's figures, considers that the male and female honey bee are somatically diploid and tetraploid respectively, the haploid number being 8. Nachtsheim's results do not agree with those of Petrunkewitsch, who found 16 chromosomes in the oocyte, nor of Meves, who demonstrated 16 in the second spermatocytes, nor with our findings, especially those relating to oogonia and egg maturation. Furthermore, Nachtsheim's results have long puzzled cytologists, but since our new evidence clarifies the situation, Whiting's views on polyploidy in the bee appear inacceptable.

Our conclusions have been reached after a study of a wealth of material which permits us to stress the following points on honey bee cytology: (1) the well-defined shapes and individuality of the chromosomes; (2) their discrete arrangement at all times; (3) the haploid-diploid constitution of the male and female, the male having 16 and the female 32 chromosomes in gonial and in normal somatic cells; (4) the invalidity of Nachtsheim's evidence regarding "*Sammelchromosomen*"; and (5) the inacceptability of Whiting's theory on somatic polyploidy in the honey bee.

We wish to acknowledge indebtedness to Mr. D. Robb for the use of an observation hive, to Mr. D. Gauld, and to many other local beekeepers for their ready co-operation in supplying suitable material, and to Mr. H. R. Ness for invaluable help with the photography. Prof. A. D. Peacock, in whose department this work has been carried on, has throughout given helpful advice and criticism.

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VENEREAL DISEASE CONTROL IN POLAND

POLAND is at present faced with a venereal disease problem against which the state of affairs in Britain appears insignificant. The incidence of venereal diseases has increased enormously over the war years and the number of fresh infections with syphilis is now calculated to be about 150,000 per year. There is a decrease in live births of about 40,000–50,000 per year, the mortality-rate from syphilis being about 11 per cent. The reason for this state of affairs is not far to seek. The Germans spared little attention for the Poles whether they were in Poland or displaced to other countries. Venereal diseases were prevalent among displaced persons, and although plans were formulated before D-day for the treatment of infected persons before they were repatriated, nothing was, in fact, ever done for them.

The Ministry of Health in Warsaw has now prepared a permanent programme for venereal diseases control and a temporary programme for immediate operations. The basic units are consultation centres for skin and venereal diseases in health centres distributed throughout the country, and there are, of course, clinics in the hospitals of the major cities.

The basis is a network of medical facilities free to all. The principle of the legal basis is that every citizen with venereal disease can, if necessary, be compelled to submit to treatment. Sources of infection are to be discovered and put under treatment. Auxiliary measures include periodic surveys of persons susceptible to infection; obligatory pre-marital examination; obligatory serum tests for syphilis in pregnant women; training of medical personnel; propaganda; control of prostitution and vagrancy; control of alcoholism; and collection of statistics. Every physician, regardless of his status, is required to determine, and report to the nearest centre, all the sexual contacts of his patients during the infectious period. Persons so named are requested to attend the centre within seven days, and if there is no response a health visitor is to be sent. If this is still unavailing, compulsion is used. Mobile ambulance units are to be used in isolated districts for treatment, propaganda, mass observation, training, etc. Training courses, to be attended at least once a year by the medical men in centres, are to be held in the main provincial centres and will include diagnostic methods, modern treatment and management of complications, control and organisation, and propaganda organisation. Propaganda will consist in popular lectures, films and slides, posters and pamphlets and anti-alcohol appeals.

This programme is directed to the rapid treatment of syphilis during 1948. The old long-term treatment is discarded in early syphilis because of the high rate of default and possibility of continuing infectiousness. Use of penicillin reduces treatment to about two weeks and the infectious stage to about the same period; but there is a risk of infectious relapse in 15 per cent of cases.

It is proposed to do sample surveys of fifteen groups of a thousand people in various areas to gain information on prevalence and distribution of disease.

The importance of accurate serological examinations is recognized and a standard (flocculation) test is to be used throughout the country. Private laboratories are to be checked each year to ensure efficiency. Serological examination is to be routine on first diagnosis of pregnancy, and for military recruits, students and workers.

In the rapid treatment scheme every doctor, in public or in private practice, is to be employed. High standards in diagnostic technique are required.

Rapid treatment is to be given to all cases of symptomatic early syphilis and to cases of asymptomatic early syphilis (up to three years from date of infection) which have not previously been treated or which have received less than one standard course of arsenic and bismuth. The treatment is to consist of 3,000,000 units of penicillin in oil-beeswax suspension given in doses of 300,000 units each day for ten days. 0·2 gm. bismuth subsalicylate is to be given on the first, fourth, seventh and tenth days of treatment. The bismuth is omitted in pregnant women. Children are to receive 200,000 units penicillin per kilo body weight.

Intensive propaganda on the necessity for early treatment and systematic follow-up and on the availability of free treatment facilities is to be carried on by posters, newspaper articles, radio and films.

The rapid treatment method is only intended for use in the early stages of syphilis, early cases of latent syphilis, in pregnant women at any stage of disease, and in congenital syphilis, inadequately treated, up to the third year. Diagnosis is to depend on the finding of *Treponema Pallidum* by dark-ground examination, a positive serum test in the presence of clinical signs, or two positive serum tests in the absence of clinical signs if the history suggests an infection of less than three years duration.

Drugs are always available at centres; but a private practitioner receives supplies only after notifying a case and sending a requisition form. This will inevitably lead to delay in starting treatment in many cases. Private practitioners may charge a fee for treatment, but have to inform the patient that the drugs are supplied free.

Follow-up after treatment consists in clinical and serological examinations once a month for the first six months, every three months in the second six months, and each six months in the second year. The cerebro-spinal fluid is examined six months and two years after treatment. Failures after rapid treatment are to receive four courses of arsenic and bismuth on the long-term plan.

The examining physician must obtain from the patient particulars of all his contacts from the time of contracting the disease (eight weeks before the first sign in the case of syphilis) until the time of diagnosis. The patient is asked to try to bring for examination all such contacts; but methods of compulsion can be used as a last resort if persuasion is unsuccessful.

The theoretical basis of this plan is excellent, embodying as it does the latest features of Anglo-American practice. It is complicated in practice by the necessity for a formidable amount of documentation on the patient, treatment, drugs, follow-up, contacts, statistics, etc. Indeed, the paper-work will consume more man-hours than diagnosis and treatment, as was the case in the Services during the War.

The choice of treatment schedule has been influenced, no doubt, by considerations of time and availability of drugs. I do not consider, personally, that the addition of 0·8 gm. bismuth subsalicylate will increase the 'cure' rate. I believe it will do no more than delay the appearance of signs of relapse in cases which will fail. There is nothing to show that bismuth and penicillin are synergistic in action. The effect of penicillin during a rapid treatment would be more likely to be enhanced by the addition of arsenic (as an arsenoxide for preference) to the schedule. This idea has, no doubt, been discarded because of the slight risk of arsenical toxic effects and because of its technical difficulties. Arsenicals have to be administered intravenously, and it is probable that Poland at the present time lacks the skilled personnel necessary to cope with these added difficulties in the vast numbers of cases to be treated.

The choice of 3,000,000 units as the total dose of penicillin is again, no doubt, governed by circumstances; but it is a minimal effective dose and ought to be doubled as soon as supplies are available. With an infectious relapse-rate estimated (conservatively in my opinion) at 15 per cent, the follow-up programme must be very carefully carried out and failures re-treated without delay if an end state worse than the original is not to follow an initial apparent success.

The Polish medical authorities are to be congratulated on a carefully prepared and ambitious plan which seems to cover the immediate needs and make a basis for a useful service in the future. The statistical service may prove of great value in the rapid assessing of any treatment schedule, and it is to be hoped that if it is a success the system will be used for comparative experiments in treatment.

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DECARBOXYLATION OF OXALACETATE BY BLOOD

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EVOLUTION of carbon dioxide from oxalacetate by washed rabbit erythrocytes at *p*H 7·4 has been reported previously[1]. Because of the solubility of carbon dioxide at that *p*H, this could at best be only a qualitative indication of the decarboxylation. Working in either phosphate or 2*M* acetate buffer, and measuring carbon dioxide formation by the standard Warburg technique, the process has been thoroughly investigated.

The process is found in the following constituents of rabbit blood, either freshly drawn or stored for periods (up to several days) on ice: whole blood, erythrocytes, erythrocyte hæmolysate, plasma and acetone powder extracts of all the aforementioned. Hæmolysates were usually the most active, whole blood, erythrocytes and plasma roughly equally active, and acetone powder extracts all slightly less active.

At *p*H 6·5, no decarboxylation of either α-keto-glutarate or pyruvate was observed, whereas oxalacetate decarboxylation was considerable; thus the system seems to be specific for that substrate.

Dialysis for 20–24 hours against distilled water caused reduction in activity. Whereas neither manganous ions (Mn^{++}) nor magnesium ions (Mg^{++}) had any influence on the decarboxylation by any of the above preparations prior to dialysis, partial restoration of activity in dialysed extracts was observed by fairly high concentrations (10^{-3} *M*–10^{-2} *M*) of manganous ions, and, less markedly, magnesium ions. Thiamine does not feature in the process under the experimental conditions employed. Added pyruvate in no way affects carbon dioxide output, so that the reaction does not seem to be a Krebs condensation to *cis*-aconitate. The process is not markedly reduced by submersion of the enzyme in water baths at 70–75° C. for periods of 1–4 min.

It must be noted that oxalacetate itself undergoes a quite rapid autodecomposition under the experimental conditions. This is very sensitive to *p*H and varies somewhat for each different oxalacetate solution, so that all experiments were invariably run with duplicate blanks containing only the appropriate buffer and the substrate. Influence of *p*H on autodecomposition of oxalacetate is shown below, that at *p*H 7 being taken as 100 for comparative purposes:

*p*H	3·5	4·0	4·5	5·0	5·5	6·0	6·5	7·0
Decarboxylation	300	280	250	180	150	150	130	100

All references made to decarboxylations are to be taken as *increases* above the autodecomposition rate, obtained after duly correcting for autodecomposition blanks.

It is suggested from the following experiments that two different mechanisms (*apart* from autodecomposition) may operate in blood under certain conditions.

Examination of the effect of *p*H showed that decarboxylation occurred for the full range tested, namely, *p*H 8·4–3·5. No experiments were carried out at *p*H values lower than 3·5. It was seen that, at the latter *p*H, very great activity is still obtained in both hæmolysates and plasma. Actually, that of the hæmolysate is definitely greater at *p*H 3·5 than at any other *p*H tested, in spite of the very large correction due to the autodecomposition, whereas plasma seemed to show optimal activity between *p*H 4 and 5. Since it seems almost certain that an enzyme of this type would not have a *p*H optimum at 3·5 (or even below this value), the existence of a second, non-enzymatic mechanism is suggested under conditions of very low *p*H. This suggestion is very strikingly supported by the following experiments in which the system was first boiled at a certain *p*H, and the decarboxylative activity afterwards determined at the same *p*H (after readjustment, if necessary).

Boiling acetone powder extracts or diluted hæmolysates at *p*H 6·5 for less than 1 min. causes almost complete cessation of the ability afterwards to decarboxylate the substrate. However, boiling the same hæmolysate or plasma samples at *p*H 3·5–4·0 not only failed to cause such reductions in activity, but usually, especially in the case of hæmolysates, a *more rapid* decarboxylation for the boiled sample was observed when compared with an unboiled control.

To account for these consistent, unusual results, the following hypothesis is suggested. At physiological *p*H, decomposition of oxalacetate is brought about by an enzymatic, heat-labile process, in which manganous ions and, to a less extent, magnesium ions, but not thiamine, are involved. The system may thus be similar to the enzymes in pigeon liver described by Evans *et al.*[2] and in bacteria by Krampitz and Werkman[3]. In more strongly acid solutions, however, a heat-stable decarboxylation appears which is due to the liberation of some substance previously not present in a free state. *This liberation is definitely accelerated by boiling in acid solution*, so that boiled samples show a more rapid evolution of carbon dioxide than the corresponding unboiled controls.

The spontaneous decomposition of oxalacetate was then further investigated in order to throw some light on this second, non-enzymatic mechanism. It was found that both manganous ions (Mn^{++}) and magnesium ions (Mg^{++}) at concentrations of 10^{-2} *M* considerably increase the autodecomposition of oxalacetate at *p*H 6·5, the former up to 75 per cent, the latter up to 40 per cent. At a final concentration of 10^{-3}, however, these effects were much less pronounced. Ammonia, considerable amounts of which are undoubtedly released during boiling at strongly acid *p*H values, did not affect the process in concentrations of 10^{-3} *M*–10^{-2} *M*, and therefore does not feature in the second process. These experiments also were carried out at *p*H 6·5. Finally, it was thought that iron, which may well be formed from hæmoglobin at low *p*H values, might account for the increases observed. It was found that, for both ferrous and ferric ions at final concentrations of 10^{-2} *M*, increases of nearly 100 per cent over a period of one hour occurred. Ferric iron appeared to be the more active of the two, and dilution of both to 10^{-3} *M* did not reduce the effect nearly as greatly as was found with magnesium and manganous ions.

It thus appears that inorganic ferric iron may account for at least a part of the second, non-enzymatic decomposition of oxalacetate observed at very low *p*H values. However, other metals or factors, such as Breusch's heat-stable tissue extract[4], cannot as yet be excluded.

Full details of this work will appear in the *Australian Journal of Experimental Biology and Medical Science*, and further work in connexion with both mechanisms is still in progress.

I wish to express my gratitude to Prof. J. G. Wood for a generous supply of the substrate, to Prof. M. L. Mitchell for continuous advice, and to M. Wellby for technical assistance.

[1] Nossal, P. M., *Aust. J. Exp. Biol. Med. Sci.*, **26**, Part 2 (in the press).

[2] Evans, E. A., Vennesland, B., and Slotin, L., *J. Biol. Chem.*, **147**, 771 (1943).

[3] Krampitz, L. O., and Werkman, C. H., *Biochem. J.*, **35**, 595 (1941).

[4] Breusch, F. L., *Biochem. J.*, **33**, 1757 (1939).

AMERICAN PHILOSOPHICAL SOCIETY

ANNUAL REPORT

The yearbook for 1947 of the American Philosophical Society, Philadelphia, Pa., covering the year January 1–December 31, 1947, is a useful reference work, with its list of officers and committees, as well as of members, biographical memoirs (including those on Joseph Quincy Adams, Irving Fisher, M. Ganberg, P. Janet, H. S. Jennings and M. Planck) and reports of meetings. A brief history of the Society by E. G. Conklin, and the charter and laws are also included.

The report of the Committee on the Library records further accessions of more material relating to Benjamin Franklin and refers to progress during the year in the American Indian linguistic projects. At a conference called on October 18, 1947, to co-ordinate a programme in American archæology with that in linguistics, it was decided to restrict the area to be studied to the Iroquois and allied groups, and to compile a union list of Indian manuscript material as well as a manual for the use of amateur archæologists for the Iroquois area.

The report of the Committee of Publications gives some details of the foreign exchange list at December 31, 1947, revision of which has continued. In addition to the European libraries, a list is being drawn up of institutions in Latin America which should be placed on the regular exchange or on a temporary list for one year. Thirty-four papers were accepted for publication in the *Proceedings* during the year, as well as seven monographs for the *Transactions* and one book for the *Memoirs* ; two new volumes of the latter were issued in 1947. A list of publications during the year is appended to this report.

The report of the Committee on Research details the general principles adopted by the Committee in regard to grants and lists of the eighty-nine grants, totalling 80,103 dollars, made from the Penrose Fund during the year, with an analysis of the distribution by subjects and a summary of grants made from July 31, 1933, to December 31, 1947, totalling 846,605 dollars. A further nine grants, amounting to 8,300 dollars, were made from the E. R. Johnson Fund, and twenty-two grants, amounting to 46,610 dollars, from the Reserve Fund for Post-War Expenditures. Among the reports from recipients of grants included in this yearbook are those from E. Hille on studies in the theory of semi-groups; W. A. Hiltner on photo-electric observations of selected Wolf-Rayet stars, the polarization of the continuous radiation from early-type stars and selected eclipsing variable stars; and from F. B. Wood on photo-electric observations of eclipsing binaries. F. F. Cleveland reports on his studies on molecular spectra and molecular structure of olefins, acetylenic compounds, diastereoisomers, hexachloroethane, hexabromoethane and other compounds, C. P. Harnwell on the construction of a new type of beta-ray spectrograph to investigate the beta-ray spectra of radio-elements emitting electrons and positrons, and H. H. Nielson on high-dispersion measurements on the infra-red spectra of the polyatomic molecules of hydrogen sulphide, acetylene, difluoromethane, dimethylacetylene, arsine and deuteroarsine. Work is described by E. Berliner on the competitive bromination of alkylbenzenes for the purpose of ascertaining a possible conjugation of alkyl groups with the benzene ring, by J. L. and E. M. Irvin on the apparent acid dissociation constants, quinoline antimalarials such as 'Pamaquine' and other 4-amino- and 4-hydroxyquinolines, and by J. F. Mead on the action of lead tetra-acetate on amino-alcohols and amino-glycols.

Studies in chemical embryology are reported by J. L. A. Brachet, on the quantitative spectrographic analysis of salt metabolism in developing *Fundulus* eggs and senescent *Drosophila* by O. C. Glaser, and on isolated embryonic amphibian cells with special reference to cellular structure, motility, aggregation and differentiation, and embryonic cell inclusions, particularly of yolk, lipochondria and microsomes by J. F. K. Holtfreter. A serological investigation of speciation and evolution, using the Libby photron-reflectometer, has been made by P. A. Moody, and experimental studies on the development of structure and function in the central nervous system of *Fundulus* embryos by J. M. Oppenheimer indicate that metrazol has a selective action on the cell-layers nearest the central canal. C. W. Clancy's investigation of the development of eye colour in *Drosophila melanogaster* suggests that the wild type allele of the vermilion gene is not only concerned with the reactions leading to the formation of the brown pigment component but also in some unknown way with the formation of the red pigment. J. F. Crow reports on the different susceptibility to ether of several closely related *Drosophila* species, H. Geiringer on the theoretical genetics of multivalent organisms, H. P. Hansen on post-glacial forest migrations and climate in Western Canada, and Ching Tsao Wei on the seed-borne diseases of soya beans. C. R. Procter has made an ecological study of a group of ferns, *Dryopteris cristata* and its relatives, in the eastern United States, and E. Girden a phylogenetic comparison of experimental drug dissociation. The electrical responses of the human retina to stimulation by light of various wave-lengths has been studied by L. A. Riggs, the application of the concepts of servo-theory to biological systems by C. L. Kreezer; and the specificity and sensitivity of a further fifty colorimetric tests for eighteen amino-acids by A. P. Kline.

In the field of social sciences, studies of wholesale commodity prices in Philadelphia during the Revolutionary War and of industrial relations in Norway are reported; and, in that of the humanities, of the prehistoric archæology of the Tangier area of Morocco, preliminary excavations at Cottonwood Cave and Pueblo, Colorado, the distribution of petroglyphs in the United States and the archæology of Marajo Island, Brazil.

WEST AFRICAN SEA-FISHERIES

MR. G. A. STEVEN'S report of his work*, as the sole fisheries development officer, under acute difficulties of war-time conditions, in Sierra Leone, a Colony where the sea-fisheries were almost entirely undeveloped, has now been published. It should prove a most valuable guide to Mr. Steven's successors, and leaves one profoundly hoping that they will find their path made smoother for them.

There is little doubt that the sea-fisheries in these undeveloped regions could be made to yield a vastly greater contribution to the sadly inadequate proportion of protein in the local diet. The small-scale trawling experiments with the *Maid Honor* (Skipper R. E. Brown) showed a yield of 86 lb. per hour from a 64-ft. headline trawl, which is sufficiently encouraging. In pre-war years a large British trawler with (say) 110-ft. headline gear, and vastly more expensive to run, could pay her way on double that yield. Since the report was written, we have been verbally informed that *Maid Honor*, still working in the same locality, is paying her way handsomely.

Fish are there in trawlable quantity, building of vessels up to the size of small motor-trawlers seems to be possible in the Colony and—probably Mr. Steven's most valuable achievement—a local team of net-makers was speedily trained to make good trawls and trammels. Machinery, of course, must be imported, but the only weak spot in the local contribution towards an incipient industry would seem to be need for further training of African seagoing trawlermen in repairing nets at sea.

One big question concerning the ground-fish remains unanswered: in the absence of fundamental knowledge of the ecology of those seas, we have no idea how much fishing the stocks can stand. Hence should any considerable industry develop, it must be controlled by guess-work, until some marine biological survey is completed. Mr. Steven justly points out that such surveys are beyond the resources of the smaller individual Colonies, for a central laboratory of some size and an ocean-going research vessel would be essential. Probably the subsequent working-up of the material would be best carried out in Great Britain, for a long experience of marine biological work overseas has left the present writer painfully aware of the almost complete absence of library facilities outside Europe (and the United States), apart from a very few of the larger cities in the greater British dominions.

Until these essential long-term researches are well advanced (which must take years of patient endeavour), there is no practical alternative to Mr. Steven's view that development officers must just go ahead developing as well as they can, and controlling as seems locally expedient; but the danger of bad or inadequate controls, when the cart is thus put before the horse, is very considerable. Mr. Steven admits this; but having worked in an area that seems to be unusually rich (from what little one knows of the fish populations of warm seas) he does not emphasize the danger of over-fishing tropical stocks, on the sudden introduction of efficient European methods, so strongly as the reviewer would have done. Probably this was because it was only too obvious at the time of Mr. Steven's tour that there could be no suggestion of over-fishing with the inadequate equipment at the disposal of the Colony; but a recent example of the type of trouble that must be guarded against has been the very rapid development of an over-fishing problem in the Australian shark fishery.

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* Report on the Sea Fisheries of Sierra Leone. By G. A. Steven. (Freetown, 1945; London: Crown Agents for the Colonies, 1947.)

Mr. Steven's descriptions of existing native fishing practice are most interesting, and must be of great value to those about to undertake similar tasks in the Colonies. The Clupeoids, so far as is known, withstand intensive exploitation better than groundfish, and here development of the *bonga* fishery could probably proceed a very long way without danger to the stocks.

The great difficulties of preservation, processing and storage of fish in a climate which is very humid as well as hot should be more clearly visualized by all concerned in such matters (as, for example, those responsible for fixing the price of ice). The demonstration that dehydration may give better value than canning for local purposes amounts to a challenge to the technicians to devise economic means for the large-scale dehydration of fish under the most adverse climatic conditions.

The biologist will follow the report more easily after reading the very brief account of the principal food-fishes of the area, giving scientific as well as local names, in one of the previous Government publications by Hornell[1], to whose pioneer work Mr. Steven refers in his introduction. That so long an interval elapsed between Hornell's report and Mr. Steven's appointment to follow it up is most regrettable.

T. J. HART

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[1] Sierra Leone Studies, **14** (1929).

CHEMICAL INDUSTRIES IN SCOTLAND

THE report of a committee appointed in May 1945 by the Scottish Council on Industry (20 George Street, Edinburgh. Pp. 39. 2*s*.) to inquire into the present conditions and post-war prospects of the chemical industries of Scotland and to recommend action to the Scottish Council is based on a survey made in 1945–46, and its publication has been considerably delayed. The section dealing with research has been rewritten; but the main recommendations and findings of the Committee remain unchanged in spite of the delay. The Committee made no attempt to define a chemical industry but limited the report to those industries covered under the various sections of *British Chemical Abstracts B*, excluding, however, those sections such as iron and steel, metallurgical industries and fuel, which were being studied elsewhere. Figures quoted in the appendix show that so far as explosives are concerned the proportion of operatives employed in Scotland is well above that calculated on a United Kingdom population basis, while in the chemical industry in general the proportion is well below this figure. The Committee, however, has throughout taken the view that Scotland cannot be treated as a separate entity when industrial development is under consideration. It has endeavoured to take a broad view and believes that any expansion of chemical industry in Scotland would have beneficial repercussions on the national economy of the whole of Britain. It also urges that a survey of an industry which so markedly depends on research involves consideration of the research facilities available in Scotland at present.

A survey of research facilities constitutes an important section of the report. This survey leads the Committee to believe that there is scope for a much more intensive application of research to problems of particular importance to Scotland, and that much of this research is of a kind which might properly be undertaken by a Government laboratory or by a research association. The principal recommendation of the report is, in fact, the formation of a chemical research committee, with representatives from industry, academic institutions and existing research associations, to formulate the problems of chemical research and development which require investigation to meet Scottish needs, to survey the facilities available for their investigation and to make recommendations for extending those facilities where required. Next, the Committee concludes that many firms have been, and still are, suffering from a shortage of labour and sometimes of technological skill. The diversity of the operations required of the workman in any manufacturing chemical process demands a high quality of labour, and on this point a conference is recommended between representatives of the Ministry of Labour and of the chemical manufacturers. Furthermore, chemical manufacturers on the whole do not yet appreciate the advantages to be derived from more adequate scientific control of chemical operations; and the Committee also recommends that their attention should be directed to the large number of graduates in pure and applied science who qualify at the Scottish universities and technical colleges every year, only ten per cent of whom at present find employment in Scotland.

Extension of the work of the Geological Survey so as to accelerate the rate of progress is recommended, and this should be given wider publicity. Indigenous raw materials such as limestone, quartz, felspar and baryta should be critically examined by the suggested chemical research committee and industrialists with the view of their utilization in new chemical development, and steps should be taken to bring the possibilities of chemical manufacturing development under the North of Scotland hydro-electric schemes before the industry. The refining and cracking of crude mineral oil in Scotland should be extended considerably and coupled with a more exhaustive utilization of coal tar as a source of chemicals. Further exploration of the potentialities of such processes as the Robinson-Brindley or the Fischer–Tropsch for organic synthesis is also recommended. Stress is laid on the importance of a substantial reduction in the cost of coal and of easing the situation in regard to Government control of raw materials and housing. Conditions for expansion of export trade are regarded as good, but conference with shipping interests is recommended on measures to avoid the burden on manufacturers caused by the tendency to transfer Scottish manufactured material to southern ports for shipment abroad.

In regard to particular industries, the Committee hopes that the newly formed Coal Tar Research Association will find a place within its organisation for a section operating in Scotland where, owing to differences in coal and methods of carbonization, special problems have to be tackled; and also that the enormous post-war demand for all types of glass will be met in part by a general expansion of the Scottish industry. Scotland should also have a considerable share in the expansion of the dyestuffs industry; but the future of the papermaking industry in Scotland is bound up with the renewed importation of esparto grass and wood pulp. The development in Scotland of viscose, other types of rayon, or entirely new fibres from vegetable protein or alginic acid, must depend entirely upon economic factors, but special attention is directed to glass fibre. There appears to be room for a steady expansion of the rubber industry in Scotland generally, in addition to developing the export market, and it is strongly urged that actual manufacture of synthetic resins should be established in Scotland. The extraction of natural drugs could well be expanded in view of the great opportunities for export, and synthetic vitamins should find a place in the well-established fine chemical industry.

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, July 5—Friday, July 9

IRISH CHEMICAL ASSOCIATION (in the Department of Chemistry, University College, Dublin), at 10 a.m.—Summer School in Chemistry.

Tuesday, July 6

SOCIETY OF CHEMICAL INDUSTRY, PLASTICS GROUP (at Manson House, 26 Portland Place, London, W.1), at 6.30 p.m.—16th Annual General Meeting; Dr. Emil Ott: "The Relation of Physical Characteristics and Chemical Structure of Cellulose Derivatives".

Wednesday, July 7

BRITISH SOCIETY FOR RESEARCH ON AGEING (at the Royal Society of Medicine, 1 Wimpole Street, London, W.1), at 11 a.m.—Conference.*

Thursday, July 8

SOCIETY FOR ENDOCRINOLOGY (in the Clinical Lecture Theatre, Middlesex Hospital Medical School, London, W.1), at 5 p.m.—Prof. Edwin B. Astwood: "Recent Advances in the Physiology of the Thyroid Gland".*

Thursday, July 8—Saturday, July 10

INSTITUTE OF PHYSICS, MANCHESTER AND DISTRICT BRANCH (in the Physics Department, The University, Oxford Road, Manchester). —Conference on "Semiconductors and their Applications".

Thursday, July 8

At 2 p.m.—"The Physics of Semiconductors".

Friday, July 9

At 9.30 a.m.—"Industrial Developments"; at 2 p.m.—"Applications".

Saturday, July 10

At 9.30 a.m.—Informal Discussions, Demonstrations and Exhibits.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

SCIENTIFIC OFFICER IN THE CHEMICAL RESEARCH DIVISION of the Ministry of Agriculture—The Assistant Secretary (Establishment), Ministry of Finance, Stormont, Belfast (July 9).

ASSISTANT KEEPER (Class II)—The Director, The London Museum, St. James's, London, S.W.1 (July 9).

ENTOMOLOGIST to work on the biology and control of the Pea Aphis, and an ENTOMOLOGIST to assist with investigations on the biology and control of the Pea Moth and to work on the development of methods of pest control—The Secretary, School of Agriculture, Cambridge (July 10).

SENIOR OBSERVER and a JUNIOR OBSERVER—The Director, The Observatories, Cambridge (July 10).

ASSISTANT PLANT PHYSIOLOGIST, ASSISTANT POMOLOGISTS (2), and an ORGANIC CHEMIST for fruit products investigations, at the Long Ashton Research Station—The Secretary and Registrar, The University, Bristol (July 10).

ASSISTANT LECTURER IN ZOOLOGY—The Registrar, The University, Leeds 2 (July 10).

LABORATORY ASSISTANT (Grade II) IN THE DEPARTMENT OF PHYSICS—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (July 10).

SENIOR LECTURERS or LECTURERS (2) IN THE DEPARTMENT OF ENGINEERING—The Registrar, The University, Manchester 13 (July 10).

PUBLIC ANALYST—The Town Clerk, Town Hall, Bolton, endorsed 'Public Analyst' (July 10).

LECTURER IN THEORETICAL PHYSICS—The Registrar, King's College, Strand, London, W.C.2 (July 12).

LECTURER IN ARCHÆOLOGY—The Secretary, Queen's University, Belfast (July 13).

ASSISTANT IN GEOGRAPHY—The Secretary of University Court, The University, Glasgow (July 15).

SENIOR LECTURER or LECTURER IN THEORETICAL PHYSICS—The Registrar, The University, Manchester 13 (July 17).

SENIOR RESEARCH OFFICER or RESEARCH OFFICER (Ref. No. 1768) to undertake research into the chemical composition of Australian pasture plants, a RESEARCH OFFICER—Ecology (Ref. No. 1769)—to undertake research on pasture ecology, and a RESEARCH OFFICER—Agrostology (Ref. No. 1770)—to conduct research into the establishment and management of sown pastures, Division of Plant Industry, Canberra—The Secretary, Australian Scientific Research Liaison Office, Africa House, Kingsway, London, W.C.2, quoting appropriate Ref. No. (July 24).

CHIEF CHEMIST, and a RESEARCH OFFICER for enzyme chemistry, physical chemistry, X-Ray crystallography, and infra-red spectroscopy—The Secretary, Wool Industries Research Association, Torridon, Leeds 6 (July 24).

SENIOR ANALYST, an ANALYST, and an ANALYST (Biochemist), in the City Analyst's Department—The Town Clerk, Municipal Buildings, Dale Street, Liverpool, with the appropriate endorsement (July 26).

MECHANICAL ENGINEERS (3, Principal Scientific Officer grade) in the Royal Naval Scientific Service, for (*a*) design and development of torpedoes, (*b*) work on small control mechanisms, and (*c*) work requiring a sound knowledge, both practical and theoretical, of steam generating plant and prime movers—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2186 (July 31).

CHAIR OF ARCHITECTURE AT NATAL UNIVERSITY COLLEGE—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (July 31).

HEAD OF THE METALLURGY DIVISION at the Atomic Energy Research Establishment—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2184 (July 31).

CHAIR OF CHEMISTRY—The Secretary, The University, Aberdeen (July 31).

CHAIR OF PHYSICS in the University of Adelaide—The Registrar, The University, Adelaide, South Australia (August 15).

MECHANICAL ENGINEERS, PHYSICISTS or METALLURGISTS for research on mechanical working problems generally, including rolling, drawing and forging, and MECHANICAL ENGINEERS to assist in research on mechanical working problems generally, in the Metal Flow Research Laboratory—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1, endorsed 'Metal Flow'.

LABORATORY ASSISTANT or TECHNICIAN with experience in some field of biological laboratory work, and a SPECIAL HISTOLOGICAL TECHNICIAN for a new research programme on radioactive tracer elements—The Professor of Zoology, The University, Bristol.

GOVERNMENT CHEMIST in the Medical Department of the Gold Coast—The Director of Recruitment, Colonial Service, 15 Victoria Street, London, S.W.1.

TECHNICAL RESEARCH ASSISTANT by the Professor of Physiology—The Secretary, King's College of Household and Social Science, Campden Hill Road, London, W.8.

SCIENTIFIC OFFICERS and EXPERIMENTAL OFFICERS in Ministry of Supply Establishments concerned with the whole field of scientific research for the Services, for Civil Aviation and for a variety of industrial purposes, in the fields of: Chemistry (Ref. F.355/48), Biochemistry, Physiology, Pharmacology (Ref. G.184/48), Aerodynamics (Ref. A.160/48), Aircraft Structural Theory (Ref. C.301/48), Gas Turbines (Ref. C.299/48), Physics (Ref. A.159/48), Radar (Ref. A.161/48), Aircraft Instrumentation (Ref. C.300/48), Metallurgy (Ref. F.356/48), Mathematical Applications (Ref. A.158/48)—Technical and Scientific Register (K), York House, Kingsway, London, W.C.2.

CHEMIST with research experience preferably, though not necessarily, in field of protein fibres—The Director, British Cotton Industry Research Association, Shirley Institute, Didsbury, Manchester.

SENIOR TECHNOLOGIST—The Secretary, British Rayon Research Association, Bridgewater House, 58 Whitworth Street, Manchester 1.

BIOCHEMIST (non-medical)—The Secretary-Superintendent, County Hospital, Lincoln.

ASSISTANT TECHNICIAN IN THE ZOOLOGY DEPARTMENT—The Registrar, University College, Southampton.

LECTURER IN LIVESTOCK HUSBANDRY—The Principal, Harper Adams Agricultural College, Newport, Shropshire.

SENIOR LECTURER, and a LECTURER, IN PHYSICS, at the University of Otago, Dunedin—The High Commissioner for New Zealand, 415 Strand, London, W.C.2.

STATISTICIANS in the newly created Statistical Department of the Government of Nigeria—The Director of Recruitment, Colonial Service, 15 Victoria Street, London, S.W.1.

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Physical Society. Report on Colour Terminology. By a Committee of the Colour Group. Pp. iv+56. (London: Physical Society, 1948.) 7*s*. net. [135

A Description of Ordnance Survey Small Scale Maps. Pp. v+21+19 plates. (Chessington: Ordnance Survey Office, 1947.) 1*s*. 6*d*. [135

A Description of Ordnance Survey Large Scale Maps. Pp. v+23+9 plates. (Chessington: Ordnance Survey Office, 1947.) 1*s*. 6*d*. [135

F.P.A. Journal. Quarterly. Vol. 1, No. 1, April. Pp. 28. (London: Fire Protection Association, 1948.) n.p. [185

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LIMITATIONS OF PLANNING

OF the many repercussions in Britain of the fuel crisis of February 1947, the shock administered to the general belief in economic planning was among the most far-reaching. Those who then began to doubt whether the best way of ordering economic affairs was to place the responsibility for all crucial decisions in the hands of the State have since been joined by many others as a sequel to the balance of payments crisis of August. Behind the resentment originally aroused by the abolition of the basic petrol ration and the direction of labour lies uneasiness as to whether the method of cure is not bringing evils worse than the disease, and endangering precious and fundamental elements of our heritage of freedom.

This is no mere party issue, and while it may still be generally admitted that we must have more State intervention and direction in our economic life than we had before the War, there is probably less disposition to regard economic planning as a magic talisman by which our difficulties may be charmed away. The recent resignation of Sir Charles Reid from the National Coal Board arouses profound misgivings as to whether under the existing conditions the technical man will be allowed to make his all-important contribution to the improvement of technical efficiency and production. Those who believed that, given time, good technique might solve the worst of Britain's coal problems, are forced to admit that mining engineers, at the moment, are not in a position to make their full contribution to the rehabilitation of the industry.

If this is true in the coal industry, nationalization of which was accepted by almost everyone as essential and appropriate, doubts cannot but grow whether the programme of nationalization will make any positive contribution to the improvement of industrial efficiency and productivity, either in the narrower technical or in the wider social and economic context. While the recommendations of the Reid Report are not implemented, the scientific worker and the technologist at least can scarcely be convinced that nationalization as such is the answer to our economic problem, if indeed they do not see in national ownership a fresh obstacle to the technical reorganisation which may be needed in more than one industry. Those doubts will be further strengthened by the opinions voiced by Sir John Henry Woods, 'permanent secretary' to the Board of Trade, in a lecture before the Institute of Public Administration last December. Indeed, that lecture, now published in the *Journal of Public Administration* (**26**, 85 ; 1948), contains unmistakable evidence that nationalization of industry in Britain at the pace set by the present Government has seriously overstrained the administrative resources of the country, as indeed both Mr. Shinwell and the Lord President of the Council have admitted.

Despite, therefore, current discussions on the possibilities of securing a better utilization of the country's resources of scientific man-power through planning based on operational research, there is probably a much wider disposition than at any time

Linlithgow Library.

since the end of the War to recognize that central planning has limits. That much was argued by Sir Oliver Franks in the very lectures to the London School of Economics and Political Science last year which Sir Hubert Henderson criticized in his Rede Lecture in May 1947. The question to-day is rather where is the frontier to be drawn between planning and freedom, given the techniques now at our disposal, the administrative possibilities and difficulties, and the social aspirations which lie behind so much of the programme of reconstruction to which the present Government no less than its predecessor is committed.

Prof. John Jewkes' recent book, "Ordeal by Planning"*, shows plainly that discussion is what is first required. Readable, fluent and clear in its diagnosis, it says much that was worth saying and will be read with approval by many who are becoming conscious that they are losing something they cherish and in danger of losing more. But its analysis is purely destructive, and Prof. Jewkes has thrown away an opportunity all the greater because the persuasiveness and clarity of his style should secure a firm hold on the reader's sympathy and understanding. He defends himself, it is true, on the plea that it is necessary to clear a field of weeds before sowing a new crop; but sometimes his destructive analysis is more like pulling up the wheat with the tares and handing over both to the destructor. Nevertheless, it is well that the relation should be established between the fall in the standard of living in Britain, the progressive restrictions on individual liberties, the ever-widening destruction of respect for law, the steady sapping of our instinct for tolerance and compromise, the sharpening of class distinctions and our growing incapacity to play a rightful part in world affairs; though it is going too far to attribute these interrelated changes to something that has happened in the last two years. The danger of liberties being filched away, of the residue of our liberal traditions disintegrating and a planned economy issuing in totalitarianism are plainly stated, but it does not follow, as Prof. Jewkes implies, that we must choose between further planning and a return to the free price mechanism.

It is, however, when he comes to discuss planning as a scientific method, planning and freedom and planning and prosperity, that Prof. Jewkes has most to say that is of direct interest to the scientific worker. Under the first heading his remarks bear closely on the organisation and activities of the nationalized industries and are given point by Sir Charles Reid's resignation and by the inability of members of Parliament to raise a question in the House of Commons regarding a recent widespread failure in power supply. The purely logical and intellectual difficulties of running a planned economy have not yet been solved, though it is pessimistic to assume as yet that they cannot be solved. Prof. Jewkes maintains, however, that central economic planning cannot be scientific. In the first place, he says, such a plan can only have a scientific purpose if it is designed to give the consumers what they want and when they want it, and to provide freedom for the consumer to decide whether he wishes to spend his money now or in the future. In the second place, the centrally planned economy is unscientific in that those who take the final decisions must always avoid the confession of failure.

It may be true that in practice the central planner does tend to avoid admitting failure, but nevertheless Prof. Jewkes' 'must' can well be challenged; similarly, the fact that central planners have often disregarded the consumers is no valid reason for asserting that they must necessarily fail to provide the consumer with the freedom on which Prof. Jewkes quite correctly insists. Here as elsewhere Prof. Jewkes indicates the essential criteria for freedom; but, pointing to present failures to meet those criteria, concludes rather too readily that they can never be met. It is well that those weaknesses should be stressed. Britain clearly is ill able to afford the waste of man-power and materials that are inherent in some of the manifestations of planning we are at present witnessing. It is not merely the growth of the administrative staff or bureaucracy. The danger of retarded technical progress, and the deterioration of the atmosphere in which fundamental research is prosecuted to which Prof. Jewkes refers cannot be ignored, and should be seriously considered.

We have to remember that in the last analysis the answer to the problem depends upon which type of economic organisation will provide the greatest incentive to effort. Prof. Jewkes points out that whether planning can evoke sufficiently powerful incentives to enable it to match the economic results of a free economy depends upon many physical, psychological and even spiritual factors bound up with the reasons why men work at all. These factors are complex and difficult to assess; but Prof. Jewkes suggests that there are two groups of workers whose output is likely to be affected adversely in the planned economy of a socialist State. The first, and larger, is that which presses for socialism in the expectation that it will lead to an easier life and bigger returns for less effort. The second and more important group is that responsible for the highest intellectual effort, such as fundamental scientific research.

Prof. Jewkes believes that fundamental research must wither in a planned economy, both because it cannot proceed in such an environment and because those who are capable of it will be disgruntled by what appears to them the foolish policy of the State in failing to provide the only environment in which they can work. He cites in support of this view the wholesale resignation of the experts on jet propulsion when the Government took over this research; and while he is here on debatable ground, the importance of incentives in this context cannot be gainsaid. It must be admitted that the whole question requires very careful examination, for there is no doubt that under present conditions the real work of the world —the patient fostering of the efficient organisation of a factory, the cultivation of craftsmanship, the extending of scientific knowledge, the teaching of the young, the healing of the sick—does tend to fall in public esteem. Moreover, there is continuous erosion or destruction of the sense of responsibility, and this may be quite as serious in its results as the decrease in the differentials in reward in a planned as compared with a free economy.

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* Ordeal by Planning. By Prof. John Jewkes. Pp. xi + 248. (London: Macmillan and Co., Ltd., 1948.) 12*s.* 6*d.* net.

Prof. Jewkes argues that the planned and centrally directed economy must inevitably undermine the economic freedoms, such as the choice of occupation, the disposal of incomes and the acquisition and tenure of property. These freedoms, while they can never be absolute, cannot be separated from the freedom of expression in all its forms or the freedom to choose and change the members of the governing body of the community, and their whittling away destroys the independent thought and criticism through which alone freedom can be preserved. However strongly we may feel that Prof. Jewkes is too pessimistic here, the danger is real; and it is well that we should be asked to consider more carefully how it is that planning, which sets out to control things, ends by controlling men.

Prof. Jewkes' argument is strongest at this point, where it directs attention to the dangers to man's moral and spiritual welfare which appear to be inherent in economic planning. Wherever the frontier is drawn between freedom and planning, the organisation we establish to serve the needs of society with the most effective techniques and administrative resources of to-day must take full account of them; we must never forget that the individual is more important than the organisation or plan designed to serve his needs.

This warning of the danger of over-organisation and of central planning is emphasized from another point of view by the lecture by Sir John Woods on the administrative problems of the Board of Trade; Sir John is frankly concerned as to whether the central machine of Government can stand for long a continuance of the pressure, and his lecture underlines all that was urged by the Select Committee on Estimates in its Fifth Report for the Session 1946–47, and by Prof. W. A. Robson in his article on "Machinery of Government, 1939–1947" in the *Political Quarterly* early this year and again in his inaugural lecture at the London School of Economics and Political Science, on the urgent necessity of reconsidering the whole pattern of the Government machine in the light of modern conditions. In particular, Sir John asks whether the work of the Board of Trade as it now stands is a business that can be administered at all; and the whole trend of his lecture suggests that the answer is that it cannot.

The trouble is generally congestion at the top, because in spite of the expansion of government departments the structure remains essentially one that was built up for much lighter and more leisurely tasks. The Board of Trade provides an excellent illustration of the position, but it also illustrates very forcibly one of the points Prof. Jewkes makes. In 1938 the Board of Trade had a staff of 2,400, of whom 60 were administrative officers: there are now 400 administrative officers and a total staff of 15,000. The main divisions of its work are in charge of fifteen 'under-secretaries', above whom are two 'second secretaries' and the 'permanent secretary', through whom theoretically all important questions pass to the president of the Board of Trade.

When the department was small, this system was a practical means of seeing that its policy as a whole was coherent; now it is what Sir John calls a 'super-bottleneck', and in practice it is not possible for everything to go to the president through the permanent secretary. Nevertheless, it is essential to keep in step the policies of some four hundred people, and in spite of all the elaborate methods already adopted to inform each section of what the others are doing, the range of activities is so wide that Sir John admits that it is still possible for somebody to go ahead with a policy only to find that it conflicts with some other line of policy being pursued elsewhere. The administrative confusion and public criticism which result involve further waste of time on remedial measures, and lead to an even greater danger: so much time is spent in being sure of keeping in step that advance is scarcely possible. In Sir John's words, "things that ought to happen do not happen while we are making sure that nobody will be upset if they do happen".

In this great department, the essential function of research or fact finding as a basis for the determination of long-range policy as distinct from day-to-day activities is not being discharged. It should also be remembered that even if we could find the able men outside the Civil Service to serve on a committee to investigate such matters, Civil servants would still have to collect the information. Whatever Prof. Jewkes may urge, and although the Government could avoid making fresh demands on the Civil Service and perhaps reduce some of the present demands, most of the work has come to stay.

Such observations emphasize the importance of such new ventures as the British Institute of Management and the Administrative Staff College, as well as the National Institute of Economic and Social Research, and the increased provision for research in social science at the universities recommended by the Clapham Committee. The training and exchange of staff, and research into problems of administration and government, will both be required before we can either evolve the most effective forms of organisation to serve our needs to-day in industry and in government, or say with certainty where the frontier between planning and freedom lies. The conclusion to be drawn from Prof. Jewkes' book, with its demonstration of the dangers and abuse of planning, is not that planning is impracticable, but rather, as Sir John's lecture indicates, that we have embarked on large schemes of planning and organisation before determining the nature of the organisation required, the precise purposes it has to serve and the limitations imposed by existing techniques and administrative ability, whether individual or collective.

This fresh warning of the dangers of planning and reminder that for the moment we have outstripped our administrative resources and capacity for organisation is really a challenge to creative thought and to fresh efforts to discover the ways of co-operation in which the vast material resources which technology has put at our command may be used for the benefit of the whole community. Whatever mistakes may have been made in planning—and they have been frequent and grievous—mankind cannot go back and abdicate the conscious control of his environment. The preservation of the rich cultural and spiritual heritage of mankind, on which Prof. Jewkes rightly lays such stress, depends on fresh advance in the patient study of human relations and institutions, and the evolution on the basis of past experience of new means to serve the more complex demands of modern society. The price of freedom is indeed eternal vigilance; but a part of that price must be the continuing, courageous and imaginative study of human organisation, inspired by a greater respect for human personality and the moral values of Western civilization.

THE MATHEMATICAL PRINCIPLES OF PHYSICS

Principia Physica

Von Hans Georg Küssner. Pp. 256. (Göttingen: Vandenhoeck and Ruprecht, 1946.) n.p.

IN this book the author presents a new conception of the general principles of physics by trying to construct an axiomatic system in which no descriptions of facts are used which are not "logically definable". Maintaining that the notion of the continuum does not fulfil this condition, he demands that metric geometry be excluded from physics altogether, and that the space-time system be put on a purely arithmetical basis. In other words, the universe is considered to be a discontinuous manifold or point lattice. Quaternion algebra is found to provide the most adequate mathematical description for such a system and to account automatically for the four-dimensionality of space-time and its splitting up into three space-like and one time-like dimensions. In contrast to the usual concept of a dynamic universe to be described by events, the new concept is that of a static universe to be described by its structure, which reflects itself in the group properties of the algebra used for this description. Accordingly, the fundamental laws of physics cannot have the form of differential equations but have to be expressed in the form of integral equations, that is, free of metric, the integrals used being essentially Stieltjes integrals, the definition of which also holds for a discrete set of variables.

These integrals extend over the whole space-time, which is in keeping with the fact that in classical physics both time directions are completely equivalent and that there is no actual difference between past and future. On the other hand, the classical concept of causality, namely, that the future as well as the past of a physical system ought to be completely predictable from a knowledge of its present state, is not compatible with this structural idea, as no exact statement at all can be made about the structure outside a certain finite region of the world lattice from a mere knowledge of the structure within. Thus only approximate extrapolations can be made, which is essentially the same as saying that in general only statistical statements about the future (or the past) of a physical system are possible. Quantum mechanics, which is of an intrinsically statistical nature, is therefore regarded by the author as only an approximation towards the real structural laws. The general theory of relativity is also rejected because it is essentially based on metric geometry.

The world (lattice) points can be classified in different ways. A class of points constituting a line of sufficient length is identified with an 'atom'. Thus the atoms have no geometrical structure and have the character of 'point charges', the charges being of two different types, electric and 'gravic', and of different magnitude. All atoms can be classified into classes of equal charge, and by the application of group theoretical arguments it is shown that only a finite number of such classes exist. Each atom is in integral interaction with every other atom. The laws of this interaction, which are the equivalent of the classical field laws of electromagnetism and gravitation, are supposed to be of the type of Maxwell's equations which, it is shown, can be formulated as integral equations of the above-mentioned character. These equations also comprise interactions between electric and gravic charges which, the author claims, are the explanation for the electric and magnetic fields of the stars. Experiments for the verification of these relations are proposed.

The principles mentioned so far cover the domain of physical laws in medium dimensions. In order to obtain the laws of macrophysics and microphysics other principles have to be added. In the first case a structural principle relating to the structure of the universe as a whole is formulated, which the author calls the "principle of equal surroundings". This, it is claimed, leads to an understanding of the expansion of the universe and a number of other cosmological phenomena, and it also disposes of the notion of an inertial mass, reducing it to the interaction with the total material content of the universe. The non-commutative quaternion algebra, on the other hand, lends itself to the introduction of quantum conditions in the form of commutation rules. In addition to Planck's constant for the electromagnetic interaction of atoms another constant for the 'gravic' interaction is introduced. This leads to a theory of a new kind of atomic disintegration which is believed to be the origin of the primary cosmic radiation, the extra-terrestrial nature of which the author denies.

The fundamental equations of the new theory contain altogether fifteen universal constants. It is well known that only three such quantities can be dimensionally independent. Hence twelve independent relations between these quantities can be established which contain only dimensionless arithmetical constants. These are identified with the twelve arithmetical group invariants of the particular kind of algebra used. This is put to the test by a comparison between the theoretical and the most reliable experimental values of the universal constants, which indeed shows most striking agreement within the limits of accuracy. Moreover, according to the above-mentioned ideas about the nature of the atoms it should, in the view of the author, be possible also to calculate, by similar methods, the masses and spins of all possible atoms in all states of excitation. The solution of this problem is also attempted but only a limited success is claimed.

Although the author repeatedly emphasizes that all new theoretical ideas must be subjected to the most rigorous tests by experiment, it is nevertheless evident that he is essentially of the opinion that complete understanding of the material world can be achieved by purely epistemological methods. This accounts for the frequent appearance of phrases like 'endgültige Erkenntnis' (final cognition). The many extremely close agreements between theory and experiment are presented as stringent evidence for the truth of the theory; but the same claims are made by other theories (like Eddington's) which are based on completely different epistemological principles. In the opinion of the reviewer none of these theories could have been developed without a previous knowledge of the experimental facts and the numerical results of the experiments. Indeed, a great number of recent discoveries about fundamental particles, etc., are definitely not 'predicted' by the theory simply because the author did not know them while developing his ideas. Thus in spite of its extremely interesting aspects the new theory can only be regarded as one of many attempts to restore order and harmony in the rather chaotic state of ideas about the material universe which has its parallel in the state of affairs concerning spiritual values. Every brave effort to achieve unification in both realms of thought is welcome, and therefore the detailed study of the ideas which are briefly outlined in this review can be warmly recommended. R. FÜRTH

ESSAYS ON ECONOMIC RECOVERY

Britain's Industrial Survival

By Ian Bowen. Pp. 204. (London: Faber and Faber, Ltd., 1947.) 12*s.* 6*d.* net.

Co-operative Communities at Work

By Henrik F. Infield. (International Library of Sociology and Social Reconstruction.) Pp. x + 182. (London: Kegan Paul and Co., Ltd., 1947.) 15*s.* net.

The World as an Economic Entity

By Business and Brotherhood and Res et Caritas. Pp. viii + 218. (Nicosia, Cyprus: Guebenlian Press, 1946.) 7*s.* 6*d.*

WITHIN a decade the concept 'economics' has gone out of vogue and 'political economy' has again taken its place. This is perhaps not so surprising at a time when attention is turned from analysis to application. Mr. Bowen is definitely a political economist; and the use of this self-styled title is evidently a warning not to expect any systematic analysis. His examination of the necessary conditions for Britain's economic recovery unhesitatingly introduces biological and political factors. Indeed, any realistic approach to applied economic problems could scarcely fail to do so. But after having read the book through, the reader might well wonder what the formulation of "the two main world economic problems"—a declining population and unemployment—has to do with the future industrial organisation of Britain, dealt with in the concluding chapter. There is no attempt to analyse fully or assess the relevant problems facing Britain and to reach, through such an analysis, certain conclusions.

The book makes pleasant reading but gives little return for study. Yet despite its two hundred pages it contains quite a wealth of economic information, presented in a rather kaleidoscopic form. There is a good section on distribution and imperfect competition and the devices used to restrain retail competition. There is also an interesting chapter on "Advertising in the Modern Economy", followed by a discussion of monopoly in manufacturing, the application of power to industry, industrial efficiency, the formation of capital, population, and overseas capital formation. Indeed, scarcely any of the chapters are without interest; but they would be improved were they treated as separate papers rather than as steps in a logical argument.

In many respects Mr. Bowen falls between two stools. The study is too factual and too detailed for the ordinary reader and not sufficiently analytical for the student. For example, in the section on the rigidity of retail margins, which is an excellent collection of informative data, it is a pity that it did not include any examination of war-time controls and the method of stabilizing prices which has not only perpetuated the fixed margin concept (and possibly petrified it, too) but also strengthened the position of retail associations. There are many other such examples, where the reader feels the study could have been pushed deeper. But this criticism at least shows that Mr. Bowen's writing provokes thought and discussion.

There are some illuminating statistics gleaned from various sources, but again one feels—possibly quite unjustifiably—that many of the correlations are perhaps just statistical freaks. Nevertheless Mr. Bowen's discussion of the organisation of the national boards makes amends. His comments are sound and his emphasis on joint consultative machinery in industry is correct, although one cannot help thinking that under his proposed organisation the influence of the State would penetrate into all spheres of the individual.

Mr. Infield's book is a study of co-operative communities in various parts of the world. This is another system of organisation for the post-war world; but it is the antithesis of nationalization. The communities are collections of individuals who are willing and able to work together as units to develop agricultural production and to promote higher standards of rural life. The purpose of the survey was to help organise co-operative communities as a vanguard of rural resettlement.

The two fundamental motives for all co-operative settlements have been religion and social reform, and the study covers a selection of communities falling into each group. There is a very illuminating analysis of the Hutterites, the New Llano Colony and the Sunrise Community, which also throws light on those communities in the past which have not survived. Examples of more recent ventures which have been included are the co-operative farms established by the U.S. Farm Security Administration (1937–43), the Mexican Ejido, the Russian Kolkboz and the Palestinian Kvutza.

The survey has been carried out in a masterly manner, and the appraisal of each type of community allows a comparison to be drawn. It discusses their economic policies, their political machinery and the results achieved. One conclusion which is immediately apparent in this study is that the absence of the co-operative spirit in any community brings a threat of failure, no matter whether those communities were founded by individuals or governments.

Mr. Infield is adverse to any rigid plan for post-war resettlement on co-operative lines, owing to the great variation in the physical conditions of each settlement and the character of the population. There is the need for a vital motive to knit the group closely together. Rational motives tend to lead to dissension.

In this context the survey discusses the requirements of membership, the administration and management and the degree of co-operation to be achieved. As a study it is both interesting and instructive; but the simple and easy style of the writer should commend this book even to the ordinary reader.

The third book under notice is a poor attempt to propound a fundamental truth—the need for Christian ideals (brotherly relationship, the author calls it)—in an economy run on business-like lines and activated by the profit motive. Some of the comments are certainly of value, but they are completely lost in the book, which is both badly written and badly printed. The reader would, indeed, have to feel very penitential to take the trouble to go through all 218 pages and winnow the chaff from the wheat.

SCIENCE AND PHILOSOPHY

Science and the Meanings of Truth

Studies Introductory to asking What is meant to-day by Physical Explanation of Nature, by Mechanisms of Cause and Effect, and by a Claim that Scientific Knowledge is True. By Dr. Martin Johnson. Pp. 179. (London: Faber and Faber, Ltd., 1946.) 12*s*. 6*d*. net.

As may be gathered from its sub-title, the central theme of this book is an examination of the meanings which have been or may be given to the word 'truth' in relation to recent developments in physics.

"Until the era of some recent researches in atomics and relativity, the advances of science were satisfactorily carried forward by alternation of simple hypothesis and experimental test; the quantities mentioned in the former were not unlike those measured in the latter, the nature of hypothesis being restricted to a certain kind which had served adequately from the Renaissance. In particular, the success of early modern astronomy, in replacing geometrical description of planetary motion as imaginary combinations of circles, by actual elliptic orbits linked causally with a theory of gravitation, had set a type of hypothesis in which a cause was assigned for activating a mechanical model or mental picture. In later uses of this kind of picture, the criterion of truth to be tested by experiment was whether the supposed and imperceptible substances underlying perceivable phenomena act in accord with the Newtonian laws found adequate for the behaviour of visible and tangible objects. Striking success followed the exploitation of this criterion of truth in the theory of gases and of heat, and the electromagnetic theory of light, and some of the simpler theory of metals."

But with recent researches in physics, this idea of cause in the sense of "forces causing changes in motion" broke down, because it became impossible to construct mechanical models. Such models have, in fact, been recognized as concepts, and scientific knowledge regarded as a system of formal relations instead of a correspondence with any external world imagined in a model.

After reviewing briefly the meanings of truth implied in the writings of Heisenberg, Dirac, Eddington, Milne, Whitehead and Russell, Dr. Johnson puts forward a view of his own. For him science rests on the postulate that Nature is intelligible, and the essential fact underlying this is for him that scientific knowledge is communicable. That is, first, after measurements have been made propositions are formulated in such a way that the results are repeatable and therefore verifiable; secondly, such statements are further judged by 'coherence' in the sense of correlating the widely different physical situations within each of which communicability has already guaranteed a degree of truth. For example, the conic sections which replaced the medieval circles in describing planetary motions could also describe the orbits of comets and were a valuable though transient help in the supposed orbits of electrons within the atom. This criterion of truth is thus a practical one—"coherence between communicable patterns of measurement". We no longer ask whether the 'wave-electron' or the 'particle-electron' are true or false "in the sense of corresponding to any permanent object with the model properties of anyone's mental picture or concept"; each theory is simultaneously 'true' as "each is communicable over its own range of physical situations".

The second part of this book is concerned with more general philosophical problems arising out of the meanings given to truth in science and in particular with the relation of the physicist's mind to the experience which comes to him from without. The discussion is confined to the types of problems arising rather than with an attempt to solve them.

This book is not easy to read, and the style is involved and not always happy. It does, however, cover many interesting topics and not its least value is that it is written by a practising physicist thinking his way through the implications of his subject.

A. C. Crombie

A GUIDE TO THE ASTROLABE

Traité de l'astrolabe

Par Henri Michel. (Ouvrage publié avec le concours de la Fondation Universitaire de Belgique.) Pp. viii + 202 + 24 plates. (Paris: Gauthier-Villars, 1947.) 1,200 francs.

There are not a few treatises, old and new, that concern themselves with that ancient and beautiful instrument, the astrolabe; but few, if any, are of use to the student or collector possessing an astrolabe who wishes to know how old it is, how it is used, and what are the principles that underly its construction. The work under review most admirably fulfils these functions, and its account of the multifarious types of astrolabe is the clearest and most reliable of those known to the reviewer.

The book is divided into two parts. The former of these deals briefly with the history of the astrolabe and goes on to a description and explanation of the various types, eastern and western. The author discounts the generally accepted ascription of the invention to Hipparchus, largely on the ground that it was not known to Ptolemy, whose *astrolabon organon* was something quite different from the instrument to which the name of astrolabe has been traditionally attached. He finds the first reference to this, the planispheric astrolabe, in the sixth-century treatise of Philoponus, who tells us that his master Ammonius (*c*. A.D. 500) had written on the subject. M. Michel's view is clearly in accord with the facts as known to us, though many students of ancient science will feel that an instrument so admirably devised and designed is unlikely to have emanated from the almost extinct fires of Greek culture. Very admirable is the author's clear account, in non-technical language, of the basic principle of the astrolabe, namely, the superposition of a movable map of the celestial sphere upon a map of the terrestrial as viewed from the locality of the observer. His explanation of the stereographic projection on which the instrument depends will be clear even to those whose geometrical equipment is of the slenderest. The book next considers the parts of the astrolabe, and enables the reader to discover the purpose of the networks of circles and arcs which are engraved on every part of these instruments ; this is particularly valuable for the understanding of the oriental types. M. Michel devotes more than one section to the practical use of the astrolabe, to which some more pretentious treatises give so little attention that the reader wonders whether their authors considered the instrument as a thing of use or only as a collector's piece : the reviewer, indeed, when first confronted with a collection of astrolabes, was forced to resort to Geoffrey Chaucer's little treatise on the subject, which explains the essentials with admirable clarity.

Astrolabes, to-day, are the prized possessions of museums and connoisseurs, and their owners are greatly interested in a matter which seemed less important to their makers, namely, the date of their construction. In the second part of the book under notice, M. Michel has assembled the methods by which such dates can be estimated. To find a date on the instrument is eminently satisfactory, yet it is not uncommon to find that this has been added and indicates the time at which the instrument was repaired or remodelled. The maker's name may be inscribed, and the book gives a very useful and full list of makers with their dates and brief notices of their work. But the collector's chief problem is the dating of the astrolabe which bears no inscription. Considerations of style and design are useful, and the series of full-page plates of astrolabes, twenty-four in number, at the end of the book is a valuable guide to those who have not been able to see a large collection of these instruments. But the most useful feature is a discussion of the dating of the astrolabe from the astronomical data implied in its markings. Thus many astrolabes are engraved with a zodiacal calendar, and the date of the first point of Aries indicates the number of days by which the Julian calendar differed from the astronomical, and therefore the approximate date. The author makes the valuable point that the difference will depend on which of the four years of the leap-year cycle the instrument was constructed and that an uncertainty of about a century may thus result. Other methods, such as those involving the alteration of the positions of the stars through the precession of the equinoxes, are more reliable, and the application of them should settle many hitherto doubtful cases.

The book concludes with a section on the use of the astrolabe for the elementary teaching of astronomy, in which connexion the late Prof. Jenkin's Oxford astrolabe, designed for such a purpose, might have received a mention.

All who have to do with the astrolabe will be truly grateful to M. Henri Michel for providing them with a valuable and much-needed instrument of research.

F. SHERWOOD TAYLOR

PUBLIC HEALTH TO-DAY

Recent Advances in Public Health

By Dr. J. L. Burn. Pp. viii+409. (London : J. and A. Churchill, Ltd., 1947.) 25*s*.

THIS book is well printed and illustrated, clearly written and, while full of factual data, is easy to read.

In a volume of this size much of necessity is omitted. We should have liked, for example, in Chapter 22 on venereal disease schemes to have had an account to show how modern methods of treatment by the sulphonamides and penicillin have changed the whole outlook on venereal diseases and advanced the prospect of their ultimate eradication. In the preface the author disarms criticism of this kind by pointing out that recent advances in public health have been on so wide a front, so quick in pace, so significant in nature, that he can only restrict himself to the task of summarizing selected features of recent progress, and has had to leave many advances of fundamental importance unnoticed.

Even with this self-imposed limitation, the field covered is very wide. The subject-matter is considered in three main parts : public health and the individual ; public health and the community ; and public health and the environment.

In the first part, admirable and succinct accounts are given of the Public Health Nursing Service in Britain ; the care of mother and child ; nursery care ; the school health services, with desirable emphasis on the provision of school meals ; health education ; mental and dental health services ; and social services, with special reference to the important work of the almoner. A chapter follows on the handicapped child ; and here due weight is assigned to the work of J. Alison Glover, who for some twenty years, in the reports of the Chief Medical Officer of the Ministry of Education and elsewhere, has adduced cogent evidence to show that in the majority of cases tonsillectomy is an unnecessary operation. Yet still one quarter of a million tonsillectomies are said by Maxwell to be performed annually in Great Britain.

The advantage of dealing with the family in the interests of public health is set out, and an informative chapter on welfare of the aged follows. This is a topical problem of increasing importance and magnitude. Dr. Burn shows what can be done here and in other countries to deal with it. In the second part, chapters of special interest are : Chapter 19, diphtheria immunization, which the Ministry of Health with the co-operation of local authorities has done so much to promote for the past twenty years ; Chapter 21, tuberculosis, with an able appreciation of the Papworth Colony and an account of mass radiography ; Chapter 23, detailing the modern work on scabies ; and Chapter 24, which describes the use of D.D.T. in the conquest of typhus fever, etc. The third part dealing with environment is the shortest in the book, but treats of such varied subjects as smokeless air, milk, road safety, cremation and garden cities. The references in each subject, together with suggested books and papers for further reading, are copious and useful.

The Medical Officer of Health of Salford has done good service to the cause he serves by writing this book, which will appeal to all those who wish to keep abreast of a progressive science.

ARTHUR S. MACNALTY

NATURE LOVER AND FISHERMAN

Travelling Naturalist

By Anthony Buxton. Pp. 224 + 31 plates. (London and Glasgow: Wm. Collins, Sons and Co., Ltd., 1948.) 10*s.* 6*d.* net.

A NEW book by Anthony Buxton is something very special for those who love Nature. He is a shrewd and careful observer, and he writes in charming, simple English prose. In this, his latest book, there is literally not one dull sentence from the beginning to the end. He permits himself a sly dig at naturalists who use long and learned words: he certainly steers clear of them himself.

The book takes us from Norfolk and Essex, Hampshire and Yorkshire, to Scotland, where he fishes the Loch of the Shieling of Angus with skill and profit. We are then taken over the sea on his magic carpet to foreign lands, and with him watch the izzard basking in the autumn sun on the high rocky ridges of the Pyrenees and, still farther afield, watch the snow partridge swing over the snowy slopes of the Caucasus at a height of 10,000 ft. above the sea. With him, we fish rivers in Norway and share his skill in hooking giant sea trout on the lightest of light tackle, and are scarce able to keep pace with him as he flies along the rocky bank of some swift-flowing, green-tinted torrent, or hurls himself, waders and all, into the icy water, to float downstream like one of his flies in order to avoid the arch of a bridge toward which a great sea trout at the end of his line is hurrying him. One of the most attractive things in an attractive book is the author's obvious joy in living. His affection and understanding for the wild creatures which he describes so well are obvious, and he deplores the effects of the prolonged Arctic spell of 1947 on wild life. His home county of Norfolk suffered as severely as any district, and the population of bearded tits has been almost wiped out. He mentions the toll taken of redwings, and this reminds me that for the first time I saw not a single redwing last winter or spring in the Isle of Skye, where numbers are usually to be seen during April on their migration to Iceland.

The story (page 62) of izzard jumping over a man's back recalls the story of a small herd of red deer in the Cuillin of Skye which were descending a steep pass when two climbers came in sight of them. The deer came straight on, and the climbers threw themselves flat on the rock, each member of the herd jumping over them on its headlong downhill rush. Anthony Buxton found that the dotterel was a tame bird, and mentions that he might perhaps have stroked it had he so desired (p. 153). It is true that some dotterel are without fear of human beings. I think the most remarkable experience I ever had was when a dotterel on the nest rose from its eggs, ran over to where I was sitting a few feet away, caught a crane fly on my clothes, then looked at me in a knowing way before hurrying back to the precious eggs. His story (p. 187) of marsh harrier chicks killing and eating their younger brothers and sisters reminds me of the prolonged and bitter attacks made by one golden eaglet on the other in the eyrie, and of another eyrie which I visited where one eaglet lay dead and the other, a particularly truculent bird, although still in the downy stage, attempted to attack the human intruder.

The author (p. 195) writes needed words of protest about the bird photographer who is too much in a hurry with his hide, or who enters his hide without taking a companion with him, in order to see him in and, at the end of his watch, to see him out. Birds with very few exceptions cannot count, and when two people go to a hide and one leaves it the bird does not realize that the other has been left behind. As he says, the interest of the birds should come first, that of the photographer second. I foresee many editions of this book, which is an oasis of sanity in the desert of a mad world.

Seton Gordon

ORGANIC SUBSTANCES USED IN INORGANIC ANALYSIS

Organic Analytical Reagents

By Prof. Frank J. Welcher. Vol. 1. Pp. xv + 442. 44*s.* net. Vol. 2. Pp. xi + 530. 40*s.* net. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1947.)

THESE two volumes form part of a work which when complete should be a most useful compilation. The author's aim has been to collect information from the literature describing the uses of all organic substances in inorganic analysis. The term "analytical reagent" in the title is thus taken to include all incidental uses of organic compounds, if only, for example, as solvents in an extraction, a precipitation or a colour test. On the other hand, the operations listed are, in fact, all for the detection or determination of inorganic atoms and radicals (with the exception of tests for acetates, cyanides and cyanates) and applications to the detection or determination of organic compounds are not considered, although the title gives no indication of this.

Introductory chapters in the first volume give a useful résumé of the theory of valency with special reference to co-ordination and chelate compounds and a discussion of the effect of structure on solubility. The main part of the work is then arranged according to a rational classification of the organic compounds listed, all the various applications being included under each. Laboratory methods for preparing the reagents are given and the analytical procedures are described with sufficient working details. No attempt is made at a critical selection of the methods given, the author's aim being to include everything so that the reader may be free, either to ignore, or to attempt the improvement of, any imperfect methods described. References to the literature are given in every instance, though these cannot always be exhaustive.

From the point of view of the practical analyst using these volumes to find an analytical method for a particular substance an arrangement under analytical headings might have been more convenient. That actually adopted does, however, permit of a general discussion of the uses of any group of substances or widely used reagent, and the practical usefulness of the book must depend on the indexing. Each volume is provided with two indexes, one of organic reagents and one of analytical uses. In the latter, under each analytical problem the various organic compounds are listed alphabetically with references to the body of the work. It may be presumed that collective indexes of all the volumes will be provided when the work is complete.

These volumes are excellently printed and produced, and analysts will find in them a mine of useful information and of references to the literature.

G. M. Bennett

Země Krásná (The Beautiful Earth)

By J. K. Říha. Pp. 376. (Třebechovice, Czechoslovakia: A. Dedourek, 1948.) 540 crowns.

THE sub-title of this remarkable book states that it is "about Nature, civilisation and planning". The author is not only an architect and an engineer, but he also possesses a deep knowledge of the biological sciences and he has attempted to apply this knowledge in town and country planning. Moreover, Mr. Říha has searched old records to find out whether man had in the past attempted to co-operate with Nature in developing civilization.

It appears that in modern times, or at least in the last hundred and fifty years, the production of plant foodstuffs has increased fourfold in Bohemia. Potatoes and cereals have completely changed mankind's living conditions and made possible the extraordinary progress that is usually attributed to technology, though the author emphasizes the part played by biology in this development. He refers to an area in south Bohemia, north of Třeboň, that was converted from useless marshland to useful productivity as early as the twelfth and thirteenth centuries. Ponds and canals (one thirty-five miles long) were made, and the drained land cultivated and used to rear cattle and horses. In the eighteenth century, English influence led to the laying out of tasteful parks both here and elsewhere in Central Europe. This brings the author to his contention that modern civilization is not antagonistic to Nature and indeed succeeds best when planning is directed towards harmonizing the two. The work of the country architect should take account of climate, soil and biological laws so that a community fits naturally into its surroundings.

Other features of this nicely bound folio book, well printed on art paper, are the many fine photographs by the author and his scientific friends, and the 6,000 word summaries in Russian, French and English. J. G. F. D.

Faune de France

47: Hyménoptères tenthredoïdes. Par Lucien Berland. (Fédération française des Sociétés de Sciences naturelles: Office central de faunistique.) Pp. 496. (Paris: Paul Lechevalier, 1947.) 1500 francs.

THIS volume, the most recent in the Faune de France series, is well up to the standard of its predecessors. M. Lucien Berland is the author of the volumes on the Vespoidea and has placed hymenopterists further in his debt in having written the present monograph. Under the term Tenthredoïdes he includes not only the sawflies but also all other members of the Symphyta or Phytophaga, as they are variously known. As in other volumes in the series, illustrations are a special feature—whole insects figuring very largely and often accompanied by sketches of structural details, while larvæ are illustrated where necessary. Under each species will be found its chief synonyms, followed by a description of its external characters, the main facts regarding its habits, and its distribution in France and also in other countries. Diagnostic keys to both genera and species are particularly clear and easy to follow. Taking the book as a whole, it will also prove helpful to students of the British members of the Symphyta. At the end there is a tabular synopsis of larval characters in the different families and a list of species wherein parthenogenesis, in one form or another, is known to occur. This is followed by an enumeration of those species known to be injurious to cultivated plants and, finally, a catalogue of host plants and the species feeding upon them. This latter, it may be added, will be found particularly useful by many workers.

Birds on the Wing

By John Barlee. Pp. 128. (London and Glasgow: Wm. Collins, Sons and Co., Ltd., 1947.) 12*s.* 6*d.* net.

Birds of Malaysia

By Jean Delacour. (Pacific World Series.) Pp. xvi+382. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1947.) 25*s.* net.

The Birds of Brewery Creek

By the Rt. Hon. Malcolm Macdonald. Pp. x+334+23 plates. (London, Toronto and New York: Oxford University Press, 1947.) 21*s.* net.

BIRD books come and continue to come, being for the most part very excellent, and the three here considered are well up to standard. In "Birds on the Wing", we are shown a number of fine snapshots accompanied by excellent notes from the camera and notebook of one of our younger naturalists. "Birds of Malaysia" is of different type, for in it Captain Delacour gives us a handbook to the birds of the interesting islands of Java, Sumatra and Borneo, the Malaya Peninsula, etc., with their wealth of bird life. Here are found such ornithological gems as the giant argus and Bulwer's wattled pheasants, the great hornbills, many sunbirds and so on. This volume with its excellent line drawings is a most helpful guide to them all. The third book, "The Birds of Brewery Creek", is of yet another type, though as good in its different way. In it Mr. Macdonald, High Commissioner for the United Kingdom to Canada, tells of his observations on birds in Brewery Creek, near Ottawa, and a very joyous record it is. The illustrations are from photographs and some of them are in colour, an especially excellent one being that of a snowy owl. FRANCES PITT

The Annual Register

A Review of Public Events at Home and Abroad for the Year 1947. Edited by Ivison S. Macadam, assisted by Hugh Latimer. Pp. xii+568. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1948.) 42*s.* net.

FOR the first time in its hundred and eighty-nine years of publication, this volume has been compiled with the aid of an advisory board. The selection of the board has been entrusted to five organisations concerned with the subjects covered by the annual review. These are the English Association, the Arts Council of Great Britain, the British Association, the Royal Institute of International Affairs and the Royal Historical Society. These bodies have chosen the contributors. The "Year in Science", running to more than twenty pages, gives a wide and readable survey of the year's work and is an improvement on the articles of previous years. There is little change, however, in the general arrangement. The greater part of the volume is a review of the history of the United Kingdom, the British Commonwealth and foreign countries. Then follows a chronicle of events and reviews of literature, art, science, finance, industry, trade and law. A number of public documents include the Anglo-French Treaty, and those terms of the Yalta, Teheran and Potsdam agreements which remained secret until 1947. The volume is full, comprehensive and impartial and remains, as always, an indispensable survey of human affairs.

THE RONALD ROSS JUBILEE

ANNIVERSARIES and celebrations of medical discoveries have little except historical interest unless they have some direct bearing on present problems. In the case of malaria they have. Fifty years ago, medical men and sanitarians were given a new tool in the form of knowledge of the means of transmission of malaria from man to man. This was heralded as the immediate forerunner of a recession of malaria throughout the world. Forty years experience left these hopes unfulfilled, the new knowledge being applied on a relatively small scale and mainly to highly specialized communities such as towns, labour forces and armies, which are, of course, unrepresentative of the mass of rural tropical peoples. The last ten years work, which is now being brought together and appreciated, shows that there is no longer any reason why the original aim should not be rapidly achieved if the importance, and the limitations, of recent discoveries are fully realized by medical men, administrators, and others concerned in the health of the tropics. A restatement of past history, an emphasis on the lessons to be learnt from it, and a summary of present knowledge based on an appropriate occasion such as the fiftieth anniversary of Ronald Ross's discovery is therefore considerably more than a sentimental occasion. The Ross Institute of Tropical Hygiene, which is amalgamated with the London School of Hygiene and Tropical Medicine, has attempted this survey and assessment in the form of an exhibition open to the public throughout the past week.

Much controversy has surrounded the subject of Ross's discovery, which was finally completed on July 9, 1898. Briefly, the facts are that Laveran[1] first described the parasites of malaria in 1880, his discovery being much elaborated by Italian workers such as Marchiafava and Bignami[2]. In 1894 Patrick Manson, who had previously described a part of the cycle of development of *Wuchereria bancrofti* in a mosquito[3], suggested that this insect might in some way be an intermediary in the carriage of the malaria parasite[4], though he did not foresee the cycle as we know it. Meanwhile Ronald Ross, who had been in India since 1881 and had shown a passion for the preventive aspect of medicine, set out to discover the basic facts of malaria with the object of producing a method for its control. The present speed of dissemination of knowledge makes it difficult to accustom ourselves to the idea that even an earnest and serious worker such as he remained ignorant of Laveran's discovery, and worked on pointless side-issues, until 1894. In that year he met Manson, who demonstrated the parasite to him, set him to its study in the laboratory and in the new translation of Marchiafava and Bignami's book, and fired him with interest in his own mosquito theory. From that time these two men worked as patron and protégé, Ross carrying out all the experimental work to inquire into the theory formulated by Manson, from whom he received constant advice and encouragement.

During 1894–97 Ross worked mainly in Secunderabad, Hyderabad, on human cases of infection with *Plasmodium falciparum* and several species of mosquitoes. On August 20, 1897, he demonstrated the development of gametocytes of *P. falciparum* up to the stage of four-day-old oocysts in the gut wall of a 'dapple-winged mosquito', almost certainly *Anopheles stephensi*. This was recognized as complete proof that development of the parasite did occur in the mosquito, thereby incriminating that insect as a carrier and establishing Manson's theory, and was published in December of that year[5]. It stopped short at showing that man infected the mosquito without showing how the mosquito infected man, and again it is difficult for us to realize that this was by no means obvious.

At this stage, Ross's work was interrupted by his transfer to a remote non-malarious station. In February 1898 he was able to resume it in Calcutta, but without human material. He turned to avian material and *Culex* mosquitoes, and between February and July 1898 showed successively the ripening of the oocyst, the liberation of sporozoites into the body cavity, their invasion of the salivary glands, and the transmission of infection from an infected bird, through *Culex fatigans* to previously uninfected birds. Some parts of the story were published while the work was in progress, and the full one was communicated by Manson to a meeting of the British Medical Association on July 28, 1898, published by him shortly after[6,7,8], and after a further interval by Ross[9].

During the following six months, some Italian workers, Bastianelli, Bignami and Grassi[10], repeated Ross's observations using *P. falciparum* infections of *A. maculipennis*, and as the result of faults on one side or another an unnecessary and bitter controversy on priority ensued.

Ross left India where his discovery had been coldly received, joined the new Liverpool School of Tropical Medicine, immediately went to Sierra Leone and there in 1899 himself confirmed the full cycle of *P. falciparum* in *A. gambiæ* and *A. funestus*[11]. Manson, as the first item of work of the new London School of Tropical Medicine, confirmed the story by the celebrated Ostia experiment[12]. He and his fellow-workers lived safely in mosquito-proofed huts in the malarious Roman Campagna and brought back to England mosquitoes which infected volunteers who had never left the country.

The value of the discovery and the status of Ross were finally established by the evidence of Lord Lister[13]. Its practical value was soon demonstrated by pioneer work in Malaya[14], Ismailia[15] and Havana; but the record of its application up to 1939 was disappointing. Techniques were elaborated, mosquito larvicides such as Paris green were discovered, the possibility and value of adult mosquito destruction proved[16,17], new drugs such as 'Atebrin' produced[18] and much new knowledge of the epidemiology and entomology of malaria gained; but all this had little effect on the subject which interested Ross, namely, the prevention of malaria throughout the whole tropics including rural areas.

The period 1939–46 has seen the acquisition of much new knowledge, notably of insecticides, techniques of organisation, drugs and a further elaboration of the history of the malaria parasite[19]. For the first time this was brought together at the recent International Congresses on Malaria and Tropical Medicine in Washington, the proceedings of which are not yet in print, and considered by the Malaria Committee of the World Health Organisation[20]. The major interest of these meetings lay in the revelation that malaria control throughout whole countries, urban and rural areas alike, is not only possible but also has actually been put into practice. In Venezuela, British Guiana, Chile, the United States, Sardinia, Italy, Greece and Cyprus, malaria has either practically or entirely ended, as it has also in a rural area of Bombay Province holding some two million people, and in the extensive Kharga and Dhakla oases of Egypt. There have been marked reductions in other places, including the Union of South Africa, and invading foreign mosquitoes have been evicted from Brazil[21] and Egypt.

Two entirely separate principles have been concerned in this. The first is the total eradication of anopheline species (or anopheline genus in Cyprus), made possible by organisational techniques not dependent on new insecticides and ensuring perfection of local work; this has so far been used in areas with some natural protection against re-invasion in Brazil, Egypt, Cyprus and Sardinia. The other is the country-wide application of D.D.T. residual indoor sprays to all houses and anopheline shelters, producing control of anophelines at a level below that necessary for malaria transmission but not of the perfection needed for eradication; it is this process which is largely responsible for the recession of malaria in the United States, Venezuela, British Guiana, Chile, Italy, Greece, the Union of South Africa, and parts of Bombay Province.

The exponents of the two methods are in friendly rivalry; their methods too young as yet for accurate comparison, but both are practicable on a large scale. The tropical and subtropical world stands divided into two sections, one of which has, and one of which has not, attempted to apply either of these principles. It is regrettable to find tropical Africa in the latter group, though as yet unresolved doubt has been thrown on the value of D.D.T. in that country[22]. The Malaria Committee of the World Health Organisation has, however, agreed to support a large eradication scheme in the heart of that continent, and if D.D.T. should be valueless there 'Gammexane' (the gamma isomer of benzene hexachloride) could almost certainly take its place.

The story of these stages and of present trends was told in the Ross Institute Exhibition. If it succeeds in stimulating the British application of these new methods, the Jubilee will have been of real value.

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THE POST OFFICE RESEARCH STATION

THE earliest experimental work in connexion with the telephone and telegraph services of the General Post Office is recorded to have taken place in 1878. It was, however, not until 1904 that one or two members of the Engineering Department were relieved of their administrative duties to enable them to pursue investigations of a purely experimental nature in a room set aside for the purpose in the Central Telegraph Office. In 1909, the 'Research Section' was recognized as a separate entity, and additional laboratories in a nearby building were allotted to it. Natural expansion of the section, curbed during the First World War, was accelerated when hostilities ceased, and a site of eight acres was acquired for a research station at Dollis Hill in north-west London and about seven miles distant from the Central Telegraph Office. The work was transferred to this site in 1921, when the accommodation took the form of ex-army huts; the present permanent buildings were formally opened in 1933. The activities of the Research Station expanded steadily during the inter-war period, and during the Second World War they were diverted to deal almost entirely with objectives having immediate military application. Arrears of normal development of research for the Post Office's services now require an accelerated expansion, which is being effected as rapidly as present circumstances permit.

There are at present about twenty buildings at the Research Station, used as laboratories, workshops and offices by the Research and the Radio Development Branches of the Engineering Department of the Post Office. The present staff totals about 860, of whom about 470 are directly engaged on experimental or theoretical work (including some 275 who are engineers or scientific workers with full professional qualifications or have nearly attained them). About two hundred are employed in the workshops and drawing office. The experimental work of the Department is not confined to the Research Station; there are small laboratories in other parts of the country, and some experimental work has to be done in the field.

The activities of this Research Station are mainly directed towards improved and economical working of Post Office services, especially the telecommunication services, because for these there is wide scope and need for the application of the development of physical science. Apart from some radio equipment, almost all the necessary plant for these services is obtained by purchase from manufacturing companies. For the development and introduction of new types of apparatus into service, the Post Office maintains close liaison with the principal British manufacturers of telecommunication equipment, and a regular procedure exists for exchanging information concerning, and co-ordinating the development of, much of the equipment that is procured. There is also liaison and, when necessary, co-ordination with other Government research establishments and, on the international plane, with other telecommunication administrations. Broadly speaking, therefore, the main function of the Research Station at Dollis Hill is to contribute to advances in telegraphy, telephony and radio and to give guidance on their applications to Post Office services. Some of the investigations, important though limited in scope, arise from the day-to-day operation of the services and are concerned with existing plant; others are of a long-term character and represent, perhaps, seeds of the telecommunication plant of the future.

Many of the developments (to which the Research Station has contributed) produce results which are by no means immediately obvious to the users of the telecommunication services. The continued, and sometimes rapid, growth of the telephone network in Great Britain could not have been achieved, or only at much greater expense, without entirely new techniques in telephone transmission, such as the use of one pair of conductors to provide speech channels for many simultaneous conversations. Economies resulting from the introduction of more efficient types of equipment cannot be made to give immediate benefit to the users, in terms of lower charges, because, for the very large and dispersed plant which comprises the telephone network, any large-scale replacements must necessarily be spread over a very long period. When costs of labour and materials are tending to rise, the effect of such economies is more likely to appear as a lower increase in the charges for the service than would otherwise be necessary. On the other hand, some developments, for example, those which open up new services or facilities for the user, are more obvious; a case in point is the 'speaking clock'. This was the result more than eleven years ago of research into an electric drive starting from a 'free' pendulum and other research on sound-recording on glass disks.

Modern technique for telephone transmission over long land-line routes is to concentrate a number of telephone conversations on to a single pair of conductors, the conversations being separated on the route by occupying different bands of the frequency spectrum. Thus, the traffic capacity of a route is determined by the total band-width of frequencies it can carry rather than by the number of conductors it contains. With wide-band amplifiers (or 'repeaters') spaced at intervals of about six miles on a modern coaxial (or concentric) type of cable, two coaxial tubes can carry more than six hundred separate conversations simultaneously. This technique of wide-band transmission is being still further developed for the transmission of television to programme centres at different parts of Britain. Short lengths of wires in ordinary telephone cabling can be 'equalized' for carrying television signals locally, but for long-distance line transmission of television, the newer types of cable are essential.

By means of frequency separation, several telegraph transmissions can be sent simultaneously over a single telephone circuit independently of whether the telephone circuit is on a radio link, a coaxial cable, or by normal transmission over a pair of wires.

The Post Office Research Station has played a leading part in the development of semi-automatic means of switching long-distance telephone circuits. These enable the trunk operator at the calling end to actuate switches by dialling over the long-distance line and avoid the delay which arises when she is dependent on the assistance of other operators at the remote exchanges. The methods of dialling which are used in local areas could not be extended to the long-distance lines, and a system had to be worked out in which all the signals could be transmitted by currents in the speech frequency range without mutual interference between speech and signals. This system is now working on more than three thousand British long-distance circuits.

For telephoning overseas, either submarine cable (for the shorter distances) or radio links have to be used. In the case of the cable, a substantial advance has been made towards increasing the band-width of frequencies (and hence the number of simultaneous conversations) transmitted by inserting a submerged repeater. The repeater has to be capable of continuous operation under water without any maintenance for several years, with power for its valves supplied along the cable. The repeater which the Research Station constructed in 1943 for the Holyhead – Isle of Man cable was the first submerged repeater to be inserted in a working telephone cable anywhere in the world. The scheme is being developed to enable several repeaters to operate along a submarine cable, with facilities for testing and supplying power to each one from the shore ends.

Long-distance, short-wave radio links have been greatly improved since their inception by the use of single-sideband radio transmitters and receivers. On the trans-Atlantic link, reception from the United States has been made much better by the employment of special receivers and an aerial system, two miles long, installed at the radio station at Cooling (Kent). This equipment separates the mutually interfering waves by which the signals arrive after successive reflexions from ionized layers in the upper atmosphere, and so reduces the effects of distortion and noise. The study of other means for dealing with these effects has been facilitated by a laboratory device for simulating them under controllable conditions. Since 1934, radio links on much shorter wave-lengths have been used for extending the telephone network to islands around the coast of Britain; equipment operating on the frequency-modulation system was first installed on one of these links in 1942.

The Post Office not only operates radio telephone and telegraph services to all parts of the world, including ships at sea; it is also the Department responsible for control and regulation of radio communication. This responsibility involves the need for very exact measurements of any frequency which may be used. The applications of piezo-electric quartz crystal vibrators has been studied since 1925 for frequency control of radio transmitters and for frequency measurement, and the Research Station possesses one of the most comprehensive frequency standard installations in the world. It has provided quartz clocks, the most accurate timekeepers now known, to the Royal Observatory, Greenwich. Other piezo-electric materials are being studied for various applications, notably as components in the electrical circuits used for frequency selection and separation.

Telephone instruments are electro-acoustic devices, so there is need for acoustical as well as electrical measurements; the techniques for acoustical measurement have been developed much more recently than their electrical counterparts. The Research Station has contributed to these developments and it maintains a standard and equipment for the measurement of sound pressures at any desired point, in the open or in a confined space, so that objective measurements of the performance of telephone instruments of any type can be made in conditions appropriate to their use. It also has to set and maintain a standard of 'telephone transmission', which is based on subjective tests and is therefore of a less tangible nature, combining physics with physiology. Recording of sound is studied for special applications by the Post Office; two techniques have received particular attention, namely, sound tracks on glass disks for frequent repetitions of short announcements, and lacquer-coated metal disks for high-quality gramophone recording, usable (for short life) by direct play-back.

New developments and applications of electronic devices are of vital importance to telecommunications. Facilities for the manufacture of experimental types of thermionic valves enable, for example, knowledge to be built up concerning the causes of their eventual failure and may be helpful towards the provision of the very long-life valves required for submerged repeaters. Such facilities also open the way for development of a few special valves for special uses. Techniques of application, such as are used in electronic computers, are studied; in fact, an elementary form of electronic computer has been made for dealing with some specific problems of plant provision and arrangement at automatic exchanges.

The main exception to the concentration of effort at the Research Station on telecommunication problems is the work that is being done to explore the practicability of introducing more mechanical processes in the handling of mail. Machines incorporating photo-electric devices can be devised to work at high speed for stacking letters, all with the stamps in correct position to be fed into stamp-cancelling machines, and also for enabling sorters to direct letters into a much larger number of sorting compartments than can be reached by hand. Considerable experimental and development work is necessary before any machines of this kind can be proved to be practicable.

LAND AND POVERTY IN THE MIDDLE EAST

DURING the Second World War, the Middle East Supply Centre—the history and achievements of which should be made public before memory fades—acted in various directions as a regional authority over an area embracing about fourteen territories, and extending from Persia to Tripolitania, and from Cyprus to Ethiopia. One of its important short-term objectives was to encourage increased food-production in the Middle East territories, to offset the unavoidable restrictions due to war conditions. This immediate objective threw into sharp relief the need for a comprehensive regional survey of the basic underlying problems of the Middle East—in particular, land utilization, peasant economy and social organisation—and this task, among others, was given to an Anglo-American Scientific Advisory Mission, the reports of which have now been published by the Stationery Office[*]. War conditions threw the Middle East territories into close association, and emphasized the fact that they had many common basic obstacles to overcome before any post-war social and economic development was possible.

There were high hopes that some form of regional organisation would succeed the Middle East Supply Centre, to serve these non-political aims. But political inexperience and short-sighted nationalism were too strong. Chatham House has, not for the first time, attempted to fill the gap by publishing a series of studies on social and economic problems in the Middle East. The pamphlet[*] under review is the first of the series; it deals with Egypt and the Fertile Crescent—Palestine, Transjordan, Syria, Lebanon and Iraq. Dr. Warriner describes the vicious circle enclosing the peasant cultivator in these regions; but the description is equally true for other Middle East countries, and for India. It is essentially an absentee landlord system, with a form of land tenure under which the tenant suffers the maximum disadvantages. Government of the country is largely in the hands of the landlords, most of whom believe their immediate interests would be threatened by any measures designed to improve the tenants' lot. The tenant is wrapped in a fatalism, which is founded on his poverty and helplessness, and reinforced by the technical difficulties of agriculture—especially of peasant farming—in tropical and sub-tropical climates and soils. The social and environmental circumstances that brought about in England the change from the open three-field system to the four-course rotation on enclosed farms do not exist in the Middle East.

Dr. Warriner examines in detail the alternative possibilities. Although most of the suitable land and a good deal of the marginal areas are already settled to capacity or beyond, there are under-populated spaces in the Jezira region of Syria; in Iraq, with better regulation of water supplies, there could be absorbed some five million people, and she points out, as one item in the immensities of the Middle East problem, that this is an authoritative figure for the surplus rural population in Egypt alone.

On the question of quick technical improvements in agricultural methods, Dr. Warriner rightly concludes that these are strictly limited, first, by our present lack of knowledge of tropical agricultural science (a point that cannot be overstressed), and secondly, by the limitations of the existing system of peasant agriculture. Further, such improvements could only be short-range palliatives, for, in the present stage of social emergence of the peasant, any increase in output per acre is more than offset by an increase in the population. At present there appear to be two possibilities only for increasing the output: the development of irrigation under State ownership and control; and, in the drier areas, mechanized dry farming on a village co-operative basis. Both involve a basic change in land tenure customs, and the second especially calls for less, not more, workers per acre.

Dr. Warriner discusses my first proposal for a tripartite organisation that would circumvent the grave obstacles of land ownership and inheritance laws. The proposal is as follows. The Government takes over, on a long lease, land from its present owners, and sub-leases the whole area to a body of the public utility corporation type. This body reconditions the land, divides it into economic units and lets them to tenant farmers for whom it performs certain desirable services—such as bulk-marketing of any cash crops—and from whom it requires certain standards of farming as a condition of the lease. In concluding that this model would not be generally applicable, because it depends on the existence of a special market for which the corporation can finance sales and organise production in relation to the market, Dr. Warriner has rather missed the point of the proposal. It is true that in certain of the examples given by me this aspect is prominent and that it even initiated some of them. But it is not the essential requirement, which is, of course, the circumventing of the land ownership laws: without some such device, an agrarian revolution, expropriation and the rest, are sooner or later inevitable. There is no reason why the proposal should not apply to subsistence crop production; the general financial level would be lower and the operations of the corporation more modest, approximating to what would be done by a co-operative buying and selling society, composed of the tenants themselves. Organisations of this type were working well among the Bulgarian peasant proprietors before the War, and their success was not dependent on the fact that the peasant owned his farm.

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[*] The Agricultural Development of the Middle East. By Dr. B. A. Keen. 5*s.* net.
Middle East Science. By Dr. E. B. Worthington. 7*s.* 6*d.* net.
Rural Education and Welfare in the Middle East. By H. B. Allen.
Animal Industry in the Middle East. By Dr. N. C. Wright (in preparation).
(London: H.M. Stationery Office, 1946.)

[*] Land and Poverty in the Middle East. By Doreen Warriner. (Middle East Economic and Social Studies.) Pp. vii+149. (London and New York: Royal Institute of International Affairs, 1948.) 7*s.* 6*d.* net.

At the same time it is clear that lack of capital in the Middle East is an obstacle to rapid development, for it also causes peasant indebtedness to the landlord-moneylender class. Dr. Warriner examines two sources of supply: the war-time sterling credit balances and oil royalties. Both are wasting assets, and both are likely in the present conditions to enrich the few. A speculative possibility briefly mentioned by Dr. Warriner is to form, perhaps under the United Nations, an international agency to promote investment and long-term economic development. This is, in fact, the public utility corporation referred to above, on a somewhat more ambitious scale.

The pamphlet sets a high standard for the succeeding ones. It is lucidly written and the author's personal knowledge of the area has enabled her to set out the essentials of a very complicated situation.

B. A. KEEN

THE MEDICAL NOBEL INSTITUTES, STOCKHOLM

THE Caroline Institute in Stockholm, in all but name the medical university of the Swedish capital, appointed a committee in 1945 for the planning and building of new laboratories for the three departments of the Medical Nobel Institute. The Department of Biochemistry was founded in 1937 under the direction of Prof. Hugo Theorell; in 1940, Prof. Ragnar Granit was appointed to a research chair in neurophysiology, established with the aid of a gift from the Wallenberg Foundation in Stockholm, and also supported by the Rockefeller Foundation; this became a Nobel Institute in 1945. At the same time, a third department of the Nobel Institute was created, in cell research, under the direction of Prof. Torbjörn Caspersson.

During the academic year 1947–48, the three departments have been moving into their new and spacious buildings in the 'medical city' which is being created by the Caroline Institute in north-west Stockholm on an old estate known as Norrbacka. The administrative centre, the library and some of the laboratories have already moved out to the new site. The Departments of Physiology and Pharmacology are expected to move out in the autumn.

The Medical Nobel Institute was formally opened in May by the Crown Prince of Sweden and dedicated to the Nobel Foundation by Prof. Bergstrand, president of the Caroline Institute. In addition to Swedish representatives from universities and academies, Scandinavian, British and American guests were present. Great Britain was represented by Prof. E. D. Adrian, foreign secretary of the Royal Society. A dinner presided over by Dr. Ekeberg, president of the Nobel Foundation, concluded the ceremony.

In his speech, Prof. Bergstrand, president of the Caroline Institute, emphasized that the Caroline Institute needed full-time research laboratories engaged in work along the front lines of modern science, for its own sake as well as to enable it to fulfil the important task entrusted to it by the will of Alfred Nobel. The beautiful and well-equipped new laboratories, he went on to say, expressed the confidence of the Caroline Institute in the three directors appointed to lead them. Financially, the three laboratories were a joint effort: the buildings and part of the equipment came from the Nobel Fund, which also supported one of the chairs and part of its running expenses; the Government of Sweden supported the other two chairs and contributed to their annual budget; the Wallenberg and Rockefeller Foundations contributed generously to most items of the budget. Prof. Bergstrand concluded his speech by expressing the gratitude of the Caroline Institute to the donors, and, finally, extended a hearty welcome to the guests. Congratulatory addresses were presented by Prof. E. D. Adrian, Prof. W. D. Bronk, foreign secretary of the U.S. National Academy of Sciences, Prof. Linderström-Lang, director of the Carlsberg Institute, Copenhagen, Prof. A. I. Virtanen, director of the Valio Research Laboratory in Biochemistry, Helsinki, and Prof. Mohr, rector of the University of Oslo.

COLOUR TERMINOLOGY

THE Committee on Colour Terminology appointed in 1941 by the Colour Group of the Physical Society had originally two objectives: (*a*) to record definitions of terms current in the various groups of people concerned with colour; and (*b*) to examine the possibility of co-ordinating the terms commonly used. Later, in the light of the Committee's discussions, a third objective was added: (*c*) to recommend a consistent terminology. This was a significant step, as the subject of colour has very wide ramifications and there was every reason to expect very great difficulty in even approaching consistency. The report now published* shows that, provided a few key changes are made, the terms used by different technical groups can be embodied in a single scheme which avoids gross ambiguities while keeping the specialized terms of particular interests substantially intact. The nomenclature of colours themselves, as distinct from the terms used in describing and specifying them, was expressly excluded from the Committee's consideration.

In drawing up the basic list of current terms with their definitions or mode of use—a list which occupies about two-thirds of the 56 pages of the report—the Committee's net was thrown very wide. The fields covered were colour physics (general, photometric, subjective and colorimetric terms), colour vision, colour-atlas systems (Munsell and Ostwald), technologies involving colour (dyeing, paint and pigment, printing, photographic, glass and decorating industries), the painting art and the colour terms of everyday speech. The definitions are fully descriptive, and sufficient explanation of the underlying principles is given to make clear how certain expressions have come into use. In colour physics, once the distinction has been established between subjective terms describing the sensations produced and the corresponding objective terms specifying the stimulus, the definitions themselves present no serious difficulty. The case is different with technological terms. For example, in the paint and pigment industry, the term 'chalky' has a meaning which in the Committee's definition runs "An excess of white (in a match supposed to be close)". But, as is pointed out, in practice, 'chalky' frequently implies that by the addition of wrong pigments or otherwise, a pigment mixture has been made whiter than the sample and that the difference is irremediable.

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* Physical Society. Report on Colour Terminology. By a Committee of the Colour Group. Pp. iv+56. (London: Physical Society, 1948.) 7*s*. net.

The colour terms used by contemporary artists are handled very gingerly by the Committee—the proper course for an exclusively technical body—and for these and for the terms of ordinary speech no recommended usage is put forward.

The interrelations of the terms of different groups are displayed in tabular form, and in the case of the dyeing and paint and pigment industries, the different meanings of comparative terms such as 'stronger', 'dirtier', 'brighter', etc., are indicated by vector lines in colour triangles of the Ostwald type with black, white and a particular colour at the vertices.

As a first step to co-ordination the Committee drew up a self-consistent list of essential terms that could be used by all colour workers without risk of confusion. The final recommendations are based on this self-consistent list and cover nearly a hundred terms. The main changes required of different groups are as follows. In colour physics, the term 'brightness' is to be replaced by 'luminosity' when the subjective aspect is in question, and by 'luminance' when brightness as an objective or stimulus quantity is intended. The term 'shade', which at present has several different meanings in the dyeing, paint and pigment and printing industries, is to denote "darker colour of same hue and saturation". The same groups are asked to reserve 'tone' for "any small variation from another colour". 'Duller' (paint and pigment industry) is not to be used to mean "containing more black" but as "less colourful" or "less saturated", while 'deeper' is to mean "containing less white".

In a concluding section the recommended terms are compared with those proposed in the recent Colorimetry Report of the Optical Society of America. Among the comparatively few points of disagreement may be noted the American retention of the term 'brightness' for the subjective meaning of the word, while the corresponding term recommended by the British committee—'luminosity'—is used in the American report for the "ratio of the luminous flux to radiant energy flux". The latter quantity is called 'visual sensitivity' in the British scheme. It is probable that the terms 'luminosity' and 'visual sensitivity' will prove the most controversial in the Committee's recommended list.

Discussions on terminology often appear to nonparticipants as rather unproductive. But whether or not the changes recommended in this report are adopted, there can be no question that the careful exposition of present usage which it contains will be of the greatest value to workers on colour problems.

W. S. STILES

NEWS and VIEWS

Geology at the University of Liverpool:
Dr. R. M. Shackleton

DR. ROBERT MILLNER SHACKLETON, who has been appointed to the George Herdman chair of geology at Liverpool, vacant by the resignation of Prof. F. Coles Phillips, returns to the University from which he graduated in 1930 and at which he was awarded the degree of Ph.D. in 1933 for researches into the complex structure of Moel Hebog, Caernarvonshire. On leaving Liverpool, Dr. Shackleton went to the Imperial College of Science and Technology, London, with a Beit Fellowship, and joined the staff of the Geology Department of the College in 1934, becoming senior lecturer in charge of petrology in 1946.

Dr. Shackleton's field-experience has been extraordinarily extensive and varied. He has travelled widely in South and Central Africa and in Russia and Siberia. In 1935–36 he made a reconnaissance survey of Viti Levu in the Fijis, where he discovered that the plutonic rocks, previously thought to be an old basement, are of Tertiary age. During 1940–45, he served on the Geological Survey of Kenya, his chief work dealing with economic problems connected with the Migori gold-belt, the phosphate possibilities of North Kavirondo and the water supply of the Aberdare Range and Mount Kenya areas. In 1946 he returned to Kenya and made a one-man expedition to the Rift Valley, where the sequence of the artefact-bearing beds of the Pleistocene was determined and the structure of a section of the Rift Valley elucidated. Last year he took part in the Royal Society Expedition to Rusinga Island in Lake Victoria, Kenya, from which important results concerning the succession and structure of the Miocene beds in which hominoid remains occur are expected. It is to be hoped that Dr. Shackleton will find time to prepare for publication a part at least of these important results of his field-studies.

Dr. Shackleton has been a member—and largely director—of a research team from the Geology Department, Imperial College, that has been working for a number of years on a project to compare the two sides of the North Atlantic and to test the continental drift theory and in particular to determine the magnitude of any drift that may have occurred. As soon as the grasp of the structure and stratigraphy on the eastern side of the Atlantic is sufficiently firm, it is intended to proceed to the examination of Eastern Newfoundland and the coast of Labrador. His new sphere at Liverpool will provide Dr. Shackleton with increased opportunities for the continuation and completion of this attractive study.

Physiology at the Queen's University, Belfast:
Dr. A. D. M. Greenfield

THE Queen's University of Belfast announces the appointment of Dr. A. D. M. Greenfield to the Dunville chair of physiology in succession to Prof. H. Barcroft, now at St. Thomas's Hospital Medical

School (see *Nature*, **160**, 704; 1947). Dr. Greenfield was a scholar of St. Mary's Hospital, and obtained first class honours in physiology in the B.Sc. examination of the University of London. After holding posts at St. Mary's in both medicine and pathology, he was appointed to the Department of Physiology, under the direction of Prof. A. St. G. Huggett. A year ago he became senior lecturer in experimental physiology. Dr. Greenfield at first worked with Dr. Killick (now Professor) on acclimatization to chronic carbon monoxide poisoning. More recently, he has shown great ingenuity in devising methods for the study of the circulation both in man and animals. During the War, these were used on behalf of the R.A.F. to study the effect of variations of g on the blood pressure. Since then Greenfield has worked with Huggett on fœtal physiology and found a method for determining the rate of the blood flow in the umbilical cord. At a recent meeting of the Physiological Society he showed how the movements of a large bubble could be photographed and used to indicate the rate of the blood flow in a part of the body, as, for example, the hand. Dr. Greenfield's special knowledge of the physiology of the circulation will be of great value in Belfast, where work in this field has been in progress for some years.

Anatomy at the University of Glasgow: Prof. G. M'C. Wyburn

GEORGE M'CREATH WYBURN has been appointed regius professor of anatomy in the University of Glasgow in succession to Prof. W. J. Hamilton, who has been appointed to the chair of anatomy at Charing Cross Hospital Medical School, London. Dr. Wyburn is a pupil of the late T. H. Bryce, and graduated at Glasgow in 1925: after holding appointments in various hospitals, he returned to Glasgow as demonstrator in 1929. He became senior lecturer in anatomy in 1936, and was acting head of the Department during 1944–45. His researches include work on embryology, with special reference to bone formation, on the endocrinological aspects of reproduction, and on tissue-grafting (of skin, cartilage and cornea in particular). He was awarded the Struthers Gold Medal and Prize in 1939 for embryological research, and again in 1947 (with Dr. Paul Bacsich) for work done during the War on the repair of peripheral nerve injuries.

Mathematics at Queen Mary College, London: Dr. G. C. McVittie, O.B.E.

THE appointment of Dr. G. C. McVittie to the new chair of mathematics at Queen Mary College, University of London, is of considerable interest, not only because he will be the first professor of mathematics at this College, but also because his appointment will go a long way towards strengthening the present somewhat meagre representation of applied mathematicians among the appointed teachers of the University. In pre-war days, Dr. McVittie was well known for his researches into relativistic theories and in particular for his trenchant criticisms of some aspects of certain forms of the cosmological theory. During the Second World War, Dr. McVittie was seconded for special service with the Meteorological Office. Here he was engaged in a number of important problems. As a result of his successful activities both as a man of science and as an administrator he was recently awarded the O.B.E. Since his return to academic life, Dr. McVittie has developed a new interest in the theoretical basis of meteorology and has been made a member of the Meteorological Research Committee. He has also become, with Prof. Ferraro, one of the editors of the new *Quarterly Journal of Applied Mathematics and Mechanics*, the first number of which has recently appeared, and which seems destined to have an important influence on the future development of applied mathematics in Great Britain. Dr. McVittie has also been very actively interested for many years in problems of theoretical astronomy and has been one of the editors of *The Observatory*.

Mathematical Statistics at the University of Sao Paulo: Mr. W. L. Stevens

MR. W. L. STEVENS has been appointed professor of mathematical statistics in the University of Sao Paulo, Brazil. Mr. Stevens worked under Prof. R. A. Fisher, at the Galton Laboratory, University College, London, during 1935–41. He then joined the staff of the Statistical Department, Rothamsted Experimental Station, for a few months on urgent war work prior to leaving for Portugal to take up a lectureship in statistics at Coimbra at the request of the British Council and the Foreign Office. In 1944 he returned to Britain and took a post as statistician with Imperial Chemical Industries, Ltd., Billingham. In 1947 he joined the staff of the Admiralty Statistical Department under Mr. H. L. Seal. He has been chiefly concerned with the development of statistical methods in the fields of biological and agricultural experimentation, and has also made contributions to the methods applicable to quality control of industrial products.

New Atomic Pile at Harwell

RATHER less than a year has passed since the Atomic Energy Research Establishment at Harwell put into operation 'Gleep', the first atomic pile to be built in Great Britain. Now a second and more powerful pile has been completed and put into operation. Its rated output is 6,000 kW., and it has been designed primarily as an experimental tool, to provide as many facilities as possible without unduly complicating the engineering of the structure. In addition, when operating at rated output, the pile should be able to produce, by transmutation of inactive elements, all the artificial radioactive isotopes required in Britain by medical and other research workers. Like 'Gleep', the new pile is a graphite-moderated air-cooled pile. The uranium rods are enclosed in aluminium cases which lie in channels in the graphite. Cooling air is drawn through the channels by several large electrically driven exhausters. The whole pile is surrounded by a concrete shield several feet thick, to protect workers from radiations, and the cooling air is discharged up a chimney stack 200 ft. high. There are about forty holes in the shield, giving access to the strong fluxes of neutrons in the interior of the pile. These neutron fluxes, many times more intense than can be obtained in any other way, are required for many experiments in nuclear science, both in fundamental and in applied research. Thus, for example, the applied research programme will include an investigation of the effect of irradiation by neutrons on the properties of materials, to provide information about materials used in the construction of piles. The experimental holes are also the means by which inactive elements are placed in the pile for transmutation into radioactive isotopes. Surrounding the pile structure are the control rooms and laboratories used by the scientific and operating staff. The operation of the pile is controlled by two sets of neutron-absorbing rods; the first set of rods is adjusted to keep the pile operating at a constant-power level, and the second set is available to shut the pile down in any emergency. The basic calculations for the Harwell pile were begun in 1945 by a team working under Sir John Cockcroft in the laboratories of the National Research Council of Canada, and were continued when the team moved to the newly formed Atomic Energy Research Establishment at Harwell. It was the first task of the Department of Atomic Energy at Risley, under the direction of Mr. C. Hinton, to undertake the design of the pile, based on the information provided by the Harwell team. This work began in April 1946. The actual construction of the pile was made the responsibility of the Ministry of Works, assisted by their contractors, Messrs. Chivers.

Earthquakes in Japan

At about 8 p.m. local time on June 28, four severe earthquakes affected the sea and land areas around the town of Fukui, on the west coast of Honshu Island, Japan. The epicentres of the shocks appear to have been near lat. 36·1° N., long. 136° E., though news from the Japanese observatories has not yet been received. An area within a radius of about 30 miles from Fukui was destructively affected. The population of Fukui (about 85,000) was largely engaged in the textile industry (mostly silk), as more than one quarter of the looms of Japan were in the town. There were some ferro-concrete buildings in the town, but most of the buildings were made of wood and these were soon set alight by the fires scattered by the shocks. The fires were difficult to check owing to earthquake damage to the water supply, and it is estimated that nearly 40,000 buildings were damaged beyond repair. A cinema collapsed, burying alive a large number of people, and many casualties were caused by falling debris at the railway station. Six other towns and thirty-nine villages in the neighbourhood were severely affected, including Marouka, Mikuni, Matsuoka, Daishoji and Kanaza. Communications were severely affected and an important railway bridge was destroyed, making relief work difficult. Huge waves lashed the coast. Altogether, some 3,200 people are believed to have lost their lives, and there are thousands of others injured. Aftershocks continued for some days.

In the whole of the densely peopled islands of Japan, there are about five hundred earthquake shocks of varying intensity every year, and although probably the greatest of the world's earthquakes have not happened there, yet there have been tremendous Japanese disasters from time to time. Examples include the Mino-Owari earthquake just after 6 a.m. local time on October 28, 1891, and the shock which almost destroyed Tokyo and Yokohama on September 1, 1923. The present shock is estimated to have been about three quarters of the strength of the latter. Between the smaller shocks of July 16–17, 1941, in the Nagano Prefecture and the shock of May 9, 1947, in Hida, there has been little news, and for part of the time some of the Japanese observatories closed down. Mr. Ernest Tillotson states that news of this period is, however, beginning to arrive: thus between December 18, 1943, and December 1945, to the accompaniment of hundreds of seismic disturbances, a 1,200-ft. high mountain called the 'New Showa Mountain' arose with volcanic eruptions on the fringe of Lake Toya, Hokkaido, similar to the Paricutin Mountain in Mexico. Further news of these tremendous earth movements is awaited.

Scientific Advisory Council to the Minister of Fuel and Power

The Minister of Fuel and Power has appointed the following to be members of the Scientific Advisory Council which will advise him on the scientific aspect of his statutory duties: Sir Alfred Egerton (chairman), Eng. Vice-Admiral Sir Harold Brown, Dr. H. Roxbee Cox, Sir Charles Ellis, Prof. F. H. Garner, Sir Charles Goodeve, Dr. E. S. Grumell, Mr. J. Hacking, Dr. H. Hollings, Prof. D. M. Newitt, Sir Harry Ricardo and Prof. S. Zuckerman. The terms of reference of the Council will be: (1) to advise the Minister of Fuel and Power on the scientific aspect of problems which he may remit to them in connexion with his statutory duty of securing the effective and co-ordinated development of coal, petroleum and other sources of fuel and power in Great Britain, and of promoting economy and efficiency in the supply, distribution, use and consumption of fuel and power, whether produced in Great Britain or not; (2) to advise the Minister of new scientific knowledge or developments which in the opinion of the Council should be taken into account in the performance of his statutory duties; (3) to keep the whole field of fuel and power under continuous review with the object of identifying problems needing scientific investigation and advising the Minister of those problems.

Ordnance Survey Maps of Britain

The initiation of an entirely new ordnance map series on a scale of 1 : 25,000, or about 2½ inches to the mile, was one of the chief recommendations of a departmental committee set up in 1935. It was felt that the gap between the 1-inch and 6-inch was too wide for many users. In the areas already covered there are signs that the new scale is growing in popularity. Some five hundred sheets, or about one fifth of the projected total, are now published, and it is hoped that the remainder will be ready in about three years time. The new map is based on the old six-inch map, to which has been added certain revisions made for war purposes. In this sense only is it provisional: the final edition will incorporate 50-in. re-surveys of built-up areas, now in hand in many towns, and an overhaul of 25-in. plans in rural areas. The sheet edges lie along the 10 kilometre grid lines of the national grid, and each sheet is known by the 10 km. grid reference of its south-west corner. The new map is sold in three styles, the fully coloured, the outline and the administrative areas. In the first, contours and main roads are in brown, water in blue, black for outlines of roads, buildings and railways, and solid black for public buildings. The outline edition is in grey monochrome without contours and is printed on specially heavy paper suitable for drawing offices. The administrative areas edition has all such boundaries shown by a red overprint on the outline edition; apparently it is being considered whether or not to continue the production of this edition. The following areas are now in the course of being covered by the 1 : 25,000 map: Greater London, Edinburgh, Glasgow, Dundee and Aberdeen; Plymouth and Dartmoor; Purbeck, New Forest, Southampton and Portsmouth, and most of the south coast; South Wales and Bristol; Gloucester, Oxford, Reading and Luton; East

Anglia and the Broads; Birmingham and district; Tyneside and Lancashire, Yorkshire and Cheshire. These maps, with the 6-in. to the mile, are known as 'medium scale'. Full descriptions of other Ordnance Survey maps, with illustrations and indexes, are given in two pamphlets, one dealing with small-scale maps and the other large-scale maps, issued by the Director General, Ordnance Survey Office, Chessington, Surrey (1*s*. 6*d*. each).

Research in Telecommunications

THE past decade has demonstrated the great importance of efficient and rapid communication as an essential part of modern civilization. Although in certain directions spectacular advances have been made in the development of telecommunications, which includes both radio and land-line signalling, there is more need now than hitherto for pursuing that fundamental research which underlies all the many applications of these techniques. In order to meet this need, the Department of Scientific and Industrial Research formed in 1946 an *ad hoc* Telecommunications Research Committee under the chairmanship of Sir Stanley Angwin, for the purpose of defining the basic problems in the whole field of telecommunications that would require investigation in the next few years. The Committee, which consisted of representatives of the radio industry, of those Government departments directly concerned with this subject, and of the British Broadcasting Corporation, drew up a report which has recently been published by the Department of Scientific and Industrial Research ("The Fundamental Research Problems of Telecommunications", London, H.M. Stationery Office, 1948. 1*s*. 6*d*. net).

This publication contains both the full reports and abstracts of the nine 'working parties' set up by the Committee to deal with the various phases of the subject. These working parties surveyed existing knowledge in their various fields to determine what deficiencies in that knowledge required attention; and they have indicated in considerable detail the specific items of research which appear to require investigation. It is believed that the formulation of these problems will prove a very useful step forward in the development of telecommunications research in Great Britain, and it is to be emphasized that university research laboratories, as well as those of government and industry, will find in the document many items suitable for their attention. With the issue of this report, the Committee has completed the task assigned to it: but the Department of Scientific and Industrial Research has already constituted a Standing Conference on Telecommunications Research, the function of which is to survey periodically the progress being made in this subject, and to provide a means for consultation between the Department's Radio Research Board and industry on these and other such matters of common interest.

Air Routes

THE advent and growing use of air transport has done a great deal to alter geographical values. Speed has reduced the importance of distance and thus recast many political, economic and social relationships. In a small pamphlet recently published ("Air Transport and Geography." London: Royal Geographical Society, 1947. 1*s*.), Mr. W. G. V. Balchin refers to many of the aspects of geography that touch on the course and uses of air routes. After referring to the vexed problem of air maps and their projections, he inserts a world map on an oblique zenithal equidistant projection centred on London and its antipodal point; on this the chief civil routes are shown. These maps show that 94 per cent of the world's population, and nearly all the world's manufacturing industry, fall in one of these hemispheres, and the central hub is in western Europe with London or Paris the actual centre. The distribution of population, especially of large urban growths, determines the course of the chief air routes. There are some forty-four world areas each of more than a million inhabitants, of which the largest are in Europe and the Atlantic side of North America and fewest in Africa and in Asia, outside China and Japan. The greatest number are on a great circle track through London and Melbourne. Major flying routes do not cross the Pacific, and contrary to often expressed belief, do not pass through north polar regions. Mr. Balchin goes on to consider other factors influencing the course of air routes.

Strawberries and Watercress as Commercial Crops

BULLETIN 95, "Strawberries" (London: H.M. Stationery Office. 2*s*. net), was originally published by the Ministry of Agriculture in 1937, but since that time so much new knowledge about the crop has become available that a new edition became necessary. This has now been accomplished with gratifying completeness, by co-operation between the scientific staffs of Long Ashton and East Malling Research Stations. All aspects of culture are discussed; but such items of practice as relate to the propagation and maintenance of healthy stock receive special mention. One section deals with newer methods of out-of-season production, and an appendix describes the recognition of varieties. The section on diseases and pests is adequate; but prompts the gentle criticism that it is scarcely complete enough to deal with some troubles which are common in the northern part of Britain. Twenty-seven good half-tone figures add greatly to the value of the bulletin.

Watercress cultivation is a fascinating speciality. Bulletin 136 (London: H.M. Stationery Office. 1*s*. net) is written by Mr. Charles H. Sansom, and gives details of all aspects of this crop. Continuous growth is given by water at about 50° F., and it is often best to obtain this by boring through chalk to a depth of 300 ft. This special crop brings special pests, for the freshwater shrimp (*Gammarus* sp.) and caddis fly larvæ cause some damage, as well as the mustard beetle. Eight plates and diagrams show details of establishment and management of the beds.

Mushroom Diseases

BULLETIN No. 10 of the Mushroom Growers' Association (Yaxley, Peterborough. 2*s*. 6*d*. net) contains a brief note by F. C. Atkins and C. J. La Touche on *Pseudobalsamia microspora*, an ascomycete which may compete with the mushroom on commercial beds. It is almost certainly introduced with the surface soil and so can possibly be eliminated with care. Boards and the house-structure should be sterilized and flies kept down, as they spread the trouble. The same bulletin contains reprints of Dr. W. M. Ware's paper on "*Clitopilus cretatus* as an Invader of Mushroom Beds" (*Gard. Chron.*, May 18, 1935), and Dr. W. F. Bewley's work on mushroom casing soil (Cheshunt Exp. Sta. Ann. Rep., 1946). A separate leaflet lists useful volumes on mushroom culture in the Association's library.

Philosophy of Science

At a meeting held at University College, London, on June 1, a Philosophy of Science Group was formally constituted and affiliated with the British Society for the History of Science. The Group adopted the following statement of aims: "The purpose of the Group is to study the logic and method of science as well as of the various special sciences, including the social sciences. The main emphasis is upon an approach through the various special sciences to the philosophy of science." The Group intends to hold meetings for the reading and discussion of papers and to publish an account of its activities in a supplement to the *Bulletin of the British Society for the History of Science*, which will be circulated to members. The Group has elected the following Committee: Prof. H. Dingle (chairman), Dr. K. R. Popper, Mr. F. I. G. Rawlins, Dr. G. J. Whitrow and Dr. A. C. Crombie (honorary secretary), Department of History and Philosophy of Science, University College, Gower Street, London, W.C.1. It is hoped to hold the first ordinary meeting in the autumn of this year.

Conference on Noise and Sound Transmission

The Acoustics Group of the Physical Society, in association with the Royal Institute of British Architects, is holding a three-day International Conference on Noise and Sound Transmission during July 14–16. This is the first major international discussion of the subject for many years, and papers will be read by European and American investigators in addition to the contributions from Great Britain. Among those reading papers are L. L. Beranek (United States); T. Vogel, R. Lehmann, P. Chavasse, F. Canac (France); W. Fürrer (Switzerland); W. K. Westmijze, C. W. Kosten, J. van den Eijk (Holland); F. Ingerslev, V. L. Jordan, P. V. Bruel (Denmark); E. Meyer, A. Schoch, L. Cremer (Germany); N. Fleming, R. S. Dadson, H. L. Kirke, W. A. Allen and A. J. King (Great Britain). The papers will cover the subjects of sound insulation in buildings, aircraft and ships; impact sound; resilient suspension systems; proposals for standardization of measurement, and the measurement of noise. Those who desire to have copies of summaries of papers in advance of the meetings should send requests to the Joint Honorary Secretaries of the Acoustics Group at 1 Lowther Gardens, Prince Consort Road, London, S.W.7.

International Congress of Industrial Medicine

The ninth International Congress of Industrial Medicine will be held in London, at the Caxton Hall, during September 13–17. The last congress was held in Frankfurt in 1938. The congress will meet in six sections devoted respectively to social aspects, environment, nursing, clinical studies, practice and legal and miscellaneous topics. Among the subjects announced for discussion are incentives, work and skill, dust hazards, pneumokoniosis, physical, biological and psychological effects of environment, effects of working with the newer chemicals and metals, hazards of radiant energy, etc. Further particulars can be obtained from the secretary of the Congress, Room 501, Garden Court Wing, B.M.A. House, Tavistock Square, London, W.C.1.

Congress on Biological Chemistry

The Société de Chimie Biologique will hold its eighth congress in Paris during October 6–8. This will be the first international congress on the subject in France for ten years, the previous meeting having been held at Liège in 1946. Subjects for special consideration at the Paris congress are: proteins and hormones (reports by Profs. Theorell and Fromageot); biological organic chemistry and plant biochemistry (reports by Profs. Stoll and Janot); vitamins and hormones (reports by Profs. E. C. Dodds and Horeau). Sessions will also be reserved for communications outside these subjects, and provision will be made for experimental demonstrations. Further particulars can be obtained from the secretary-general of the congress, M. Jean Courtois, 4 Avenue de l'Observatoire, Paris, VIe.

Science and Industrial Practice in the Iron and Steel Industry

The British Iron and Steel Research Association is arranging two conferences to be held next autumn at Ashorne Hill, nr. Leamington. The first, in which the Institute of Physics is also interested, will be held on September 8 and 9, and is to discuss non-destructive testing of castings. Three sessions will be arranged to discuss papers on X- and gamma-ray methods and on X-ray equipment, radioactive materials and radiography abroad; magnetic and ultrasonic methods; recent work by the Non-Destructive Testing Sub-Committee of the Association on the comparison of X-ray, gamma-ray and ultrasonic methods, and a paper on acceptance standards. It is intended that the papers shall deal essentially with the practical aspects of the subject and be of interest to executives not conversant with the methods, but who might be considering their use. The second conference is planned for October 21 and 22, and is to discuss foundry core bonding agents. The object is to bring to the notice of founders the wealth of information that has been obtained in recent years on the new materials that may be used for the bonding of foundry cores. The use of such materials, in many cases with an appreciable reduction in cost, would enable the linseed oil used hitherto to be diverted to alleviate the shortage of edible fats. There will again be three sessions: natural resources of the materials, recent work by the Association on the practical and fundamental aspects of bonding, and the properties of new materials such as plastics and petroleum products; experience of founders with such materials; and the impact of these materials on matters such as core-blowing, and dielectric and infra-red heating.

International Scientific Film Congress

The second congress of the International Scientific Film Association will be held in London during October 4–11. It is being convened by the Scientific Film Association of Great Britain, with the help of the British Film Institute. Three days will be devoted to business meetings of the Association, and three days to a festival of scientific films, when it is hoped to show many contributions from all the participating countries to members of the general public. The congress will close with a general assembly of the delegates on October 11. The Association was constituted last year in Paris by delegates from twenty-two countries who had accepted the joint invitation to the inaugural congress from the Scientific Film Associations of Great Britain and France. The primary aim of the Association is: "To raise the standard and to promote the use of the scientific film and related material throughout the world in order to achieve the widest possible understanding and appreciation of scientific method and outlook, especially in relation to social progress". Further details may be obtained from the Scientific Film Association, 34 Soho Square, London, W.1.

Annual Reviews of Psychology and of Physical Chemistry

An "Annual Review of Psychology" is to be published under the auspices of Annual Reviews, Inc., Stanford, California, the first volume to appear early in 1950. Prof. Calvin P. Stone and Donald W. Taylor, of Stanford University, will serve as editor and associate editor, respectively. The editorial committee will consist of the following: John E. Anderson, Institute of Child Welfare, University of Minnesota; John G. Darley, University of Minnesota; Clarence H. Graham, Columbia University; Carl I. Hovland, Yale University; James G. Miller, University of Chicago. The subject-matter of each volume will consist of critical appraisals of research proceeding in the major divisions of the field. Subjects of greatest activity will be reviewed annually, while those of lesser activity, together with any topics which encompass small divisions of the field, will be reviewed biennially.

Organisation of an "Annual Review of Physical Chemistry" of a similar type, operating under the same editorial policies and characterized by a corresponding recurring list of topics, is also announced by Annual Reviews, Inc. This will be edited by Prof. G. K. Rollefson, of the University of California, Berkeley, and will be directed in the selection of topics and authors by an editorial committee consisting of Henry Eyring, University of Utah; George Glockler, State University of Iowa; W. F. Libby, University of Chicago; J. W. Williams, University of Wisconsin; and E. Bright Wilson, jun., Harvard University. The first volume will also appear in 1950. Annual Reviews, Inc., is a non-profit corporation which was first constituted in 1932 to publish the "Annual Review of Biochemistry". Since then it has initiated the "Annual Review of Physiology" (jointly with the American Physiological Society) and the "Annual Review of Microbiology".

Zoological Society of India

The following have been elected members of the Executive Council of the Zoological Society of India: *President*, Dr. S. L. Hora; *Vice-President*, Prof. D. R. Bhattacharya; *Secretary*, Dr. M. L. Roonwal; *Editor*, Prof. K. N. Bahl; *Treasurer*, Dr. B. S. Chauhan; *Members*, Dr. K. Panikkar, Prof. M. A. Moghe, Dr. B. N. Chopra, Dr. Bhattacharya, Dr. G. D. Bhalerao, Dr. D. V. Bal, Dr. T. J. Job. It is intended to bring out the first volume of the *Journal of the Zoological Society of India* this year. Papers intended for publication, which should be original contributions or critical reviews of current researches not published elsewhere, should be sent either to the Editor (at the Zoology Department, Lucknow University, Lucknow) or to the Secretary (at the Zoological Survey of India, Banaras Cantt., U.P.).

University of Glasgow

The University Grants Committee is supporting the development of electrochemistry in the University of Glasgow; and Dr. J. C. James, at present at Battersea Polytechnic, London, has been appointed lecturer in chemistry under this project. Similar support is to be given to zoological taxonomy. Other recent appointments in the University of Glasgow are: Mrs. Rhoda M. Ainley, assistant in anatomy; J. Highet, lecturer in sociology; A. W. Sloan, lecturer in physiology; Bruno Toushek, a Nuffield fellow in physics; Mrs. Jean A. Wapshaw, part-time assistant in biochemistry; and A. Williams, lecturer in geology (with a year's leave of absence while holding a Commonwealth fellowship).

Work has been begun on the final portion of the new Chemistry Department at Glasgow, and on the building which is to house the 300-MeV. synchrotron. A 30-MeV. instrument is already in operation in the Department of Natural Philosophy.

Announcements

Prof. T. Dalling, director of the Veterinary Laboratory of the Ministry of Agriculture and Fisheries at New Haw, Weybridge, has been appointed chief veterinary officer to the Ministry from August 21 on the retirement of Sir Daniel Cabot, who has reached the age of sixty. Sir Daniel Cabot's services will be retained part-time in a temporary capacity in connexion with certain international veterinary organisations.

Mr. Alfred Eastham, chief officer of the Official Seed Testing Station since 1923, retired on June 30 and the Council of the National Institute of Agricultural Botany has appointed Mr. C. C. Brett to this post. Mr. Brett has been senior assistant to the chief officer since 1922, and during the past eighteen months has been seconded as executive officer of the Seed Production Committee.

The following have been appointed to readerships in the University of Edinburgh: Mr. E. G. Dymond (natural philosophy), Dr. W. L. Edge (mathematics), Dr. Alexander Nelson (botany) and Dr. E. G. V. Percival (chemistry).

The autumn meeting of the Deutsche Physikalische Gesellschaft in der Britischen Zone will take place at Clausthal-Zellerfeld/Harz during September 9–12.

The fourth Commonwealth Mycological Conference will be held at the Imperial College of Science and Technology, South Kensington, during July 19–24. Plant pathologists from all parts of the British Empire will be present, and the topics to be discussed include the control of virus diseases, with special reference to swollen shoot of cacao, measures to be taken to avoid the transmission of seed-borne parasites through the seed, the certification of healthy planting material of certain vegetatively produced crops, new developments in fungicides, including their application from the air, and forest pathology.

At the annual general meeting of the Institute of Welding on June 30, the following were elected honorary officers for 1948–49: *President*, Dr. J. H. Paterson; *Vice-President*, O. V. S. Bulleid; *Honorary Treasurer*, W. E. Harriss.

The Governing Body of the Imperial College of Science and Technology has decided that the schemes for the international exchange of students during summer vacations, initiated by its Vacation Work Committee in 1946, shall be broadened in 1949 to include university students from other colleges in Great Britain. The exchange is operated through the recently established International Association for the Exchange of Students for Technical Experience, which at present includes Belgium, Czechoslovakia, Denmark, Finland, France, Netherlands, Norway, Sweden and Switzerland.

LETTERS TO THE EDITORS

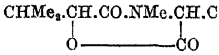
The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Antibiotics Produced by Fungi, and a New Phenomenon in Optical Resolution

It was reported earlier[1] that a strain of *Fusarium lateritium* produced an antibiotic, lateritiin-I, which was representative of a group of related compounds in presenting several remarkable chemical features. These features were elaborated in a communication to the Eleventh International Congress of Pure and Applied Chemistry held in London in July 1947, in which it was stated that lateritiin-I gave rise on hydrolysis to *D*(−)-α-hydroxy*iso*valeric acid and *L*(+)-N-methylvaline (II). The different configurations of these products were an indication, taking their configurational stabilities into account, that these units had an individual existence in the original antibiotic.

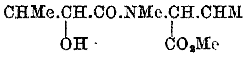
$\mathrm{CHMe_2.CH(OH.)CO_2H}$ (I) $\qquad$ $\mathrm{CHMe_2.CH(NHMe)CO_2H}$ (II)

This conclusion was supported by the isolation from lateritiin-I, after mild alkaline hydrolysis, of a lactone from which a crystalline methyl ester was prepared, the properties of these compounds being compatible with the structures (III) and (IV) respectively.



$$\begin{array}{l}\mathrm{CHMe_2.CH.CO.NMe.CH.CHMe_2}\\ \qquad\quad |\qquad\qquad\qquad\ \ |\\ \qquad\quad \mathrm{O}\text{————}\mathrm{CO}\end{array}$$

(III)



$$\begin{array}{l}\mathrm{CHMe.CH.CO.NMe.CH.CHMe_2}\\ \qquad\quad |\qquad\qquad\qquad\ \ |\\ \qquad\ \mathrm{OH}\qquad\qquad\quad \mathrm{CO_2Me}\end{array}$$

(IV)

Meanwhile Gaumann, Roth, Plattner, Ettlinger and Nager[2] had, unknown to us, reported the production by a strain of *F. orthoceras* of enniatin, which appeared to be closely related to, if not identical with, lateritiin-I. After exchanging samples of the two materials, it is agreed by Prof. Plattner and by us that a mixture of them is undepressed in melting point and that they must be regarded as identical. However, in a paper which has only recently reached us[3], it is concluded that the simple nitrogenous acid hydrolytic fragment of enniatin is probably identical with the higher homologue of (II), namely, N-methylleucine.

It seems, therefore, desirable to report that the structure of the fission product under discussion has been completely established by oxidation and by synthesis. Oxidation afforded *iso*butyraldehyde, which was identified as its 2 : 4-dinitrophenylhydrazone and 2 : 4-dinitrophenylsemicarbazone. Interaction of methylamine and lævo-α-bromo*iso*valeric acid afforded *L*(+)-N-methylvaline, identical in all respects with the material of natural origin; this was also obtained by the methylation of *L*(+)-valine in the usual way. Any remaining structural doubt has been removed by the synthesis of the lactone (III) and the derived ester (IV) in the following way. *lævo*-α-Brom*iso*valeryl chloride and *DL*-N-methylvaline were condensed together and the product was refluxed with pyridine and water, when the hydroxy-acid condensation product was formed. This was extracted and heated for several hours on the steam bath under reduced pressure, when the lactone (III) was obtained as a viscous oil similar to the natural material. This had the rotation $[\alpha]_D = +52°$ (ethanol); but on passing it through an acid-washed column in ethereal solution, about half the material was lost and the remainder had the rotation $[\alpha]_D = +79°$ (ethanol). The natural lactone has the rotation $[\alpha]_D = +82°$ (ethanol). On mild alkaline hydrolysis the synthetic material reverted to the hydroxy-acid, which on treatment with diazomethane gave the methyl ester (IV) identical in melting point with the ester of natural origin, with which it gave no depression on admixture; it was identical in all other respects with the material obtained by degradation, both showing the same optical activity, $[\alpha]_D = -128°$ (chloroform). Finally, the synthetic material yielded *L*(+)-N-methylvaline on hydrolysis.

The above reactions virtually constitute a facile resolution of N-methylvaline; apparently the lactone derived from *D*-α-hydroxy*iso*valeryl-*D*-N-methylvaline is more strongly absorbed on the alumina than that derived from *D*-α-hydroxy*iso*valeryl-N-methylvaline and undergoes hydrolysis. The lactone and derived hydroxy-acid pairs are, of course, not mirror images and no new theoretical principle is involved, nor is this an asymmetric synthesis in the conventional sense. The process is, however, unexpectedly simple; it might have considerable utility if it were general, and it clearly offers interesting speculation on the genesis of optically active amino-acids from existing optically active compounds.

Using the same procedure and starting with *DL*-α-brom*iso*valeryl chloride and *DL*-N-methylvaline, a crystalline optically inactive lactone was obtained, which was also formed by mixing equal amounts of the natural lactone with that derived from *L*-α-hydroxy*iso*valeryl-*D*-N-methylvaline.

A number of lactones similar to (III) have been made and are being studied, and full details of the present and related work will be published elsewhere.

Note added in proof.—Since the above was written a further communication (Plattner, Pl. A., and Nager, U., *Helv. chim. Acta*, 31, 665; 1948) has come to our notice in which 'enniatin A' and 'enniatin B' were described. Of these 'enniatin A', which appeared to be identical with lateritiin-I, afforded N-methylleucine, while N-methylvaline arose from 'enniatin B'. The above authors suggested that lateritiin-I was highly contaminated with 'enniatin B'. It must be emphasized, however, that we find no evidence to support this contention, the various degradation products affording no sign of heterogeneity.

A. H. Cook
S. F. Cox
T. H. Farmer

Imperial College of Science and Technology,
London, S.W.7. March 24.

[1] Cook, A. H., Cox, S. F., Farmer, T. H., and Lacey, M. S., *Nature*, **160**, 31 (1947).

[2] Gaumann, E., Roth, S., Plattner, Pl. A., Ettlinger, L., and Nager, U., *Experientia*, **3**, 202 (1947).

[3] Plattner, Pl. A., and Nager, U., *Experientia*, **3**, 325 (1947).

The Antibiotic Agent from *Marasmius ramealis*

It has earlier been shown that species of the genus *Marasmius* produce substances inhibiting the growth of *Staphylococcus aureus*[1]. Our investigations now show that *Marasmius ramealis* Fr. exercises an antibiotic effect upon various pathogenic bacteria *in vitro*.

The *Marasmius* strain used was isolated and investigated for nutritional requirements by Lindeberg[2]. The fungus was grown upon different media, the most suitable one being a modification of the Czapek-Dox substrate. Erlenmeyer flasks containing 25 ml. of the nutrient solution were inoculated and incubated at 25° C., and the culture liquid tested for antibacterial activity at different intervals against: (1) bacteria named in the accompanying table (State Bacteriological Laboratory) and (2) human tubercle bacilli (Institute of Physiological Botany).

The inhibitory action against the former bacteria was tested on solid media using a modification of the cylinder plate method due to Schmidt and Moyer[3], and in dilution series in broth. The solid medium was buffered with phosphates to neutralize the bacteriostatic effect caused by an acid solution. The bacterial concentration in the surface layer was 10^{-4} or 10^{-5} of a 20-hr. broth culture, giving a confluent growth. The plates with porcelain covers were kept at room temperature two hours before incubation at 37° C. overnight. The zones of total inhibition were read to the nearest 0·5 mm. The action on different bacteria is shown in the table.

Dilution tests were performed in broth with inocula of about 10,000 organisms per ml. The last tube showing no visible growth was determined after 20 hours incubation at 37° C. (see table). It was evident from secondary platings of the tubes that the antibacterial action was a bacteriostatic one.

	Inhibition zone (mm.)	Max. dilution for inhibition
Staphylococcus aureus, *H*	23·0	1/32
Staphylococcus aureus, 209 *P*	22·0	1/16
Streptococcus hæmolyticus, S.B.L.	0	
Diplococcus pneumoniæ, S.B.L.	28·0	
Klebsiella pneumoniæ, Friedländer *C.G.* 8	27·0	1/8
Salmonella typhi, *I.S.* 57	13·0	1/4
Salmonella paratyphi B, *I.S.* 3	10·0	1/2
Escherichia coli, *C.G.* 16	0	
Aerobacter aerogenes, *C.G.* 4	15·0	1/2
Shigella sonnei, S.B.L. 5	9·0	1/2
Proteus vulgaris, S.B.L. 2	19·0	1/2
Fœcalis alcaligenes, S.B.L.	14·5	1/8
Pseudomonas æruginosa, S.B.L.	0	
Bacillus subtilis, 219 *P*	42·0	1/256
Bacillus anthracis, S.B.L. 1	30·0	1/16
Corynebacterium diphtheriæ mitis, S.B.L.	0	
Hemophilus pertussis, S.B.L.	0	

For the tubercle bacilli, the serial dilution method was used. The *Mycobacterium* cultures employed were two strains of *M. tuberculosis* var. *hominis*: the *H* 37 *Rv* strain (obtained through Dr. Lagergren, of the State Bacteriological Laboratory, Stockholm) and the 1354 strain (isolated by Dr. Zetterberg, Institute of Hygiene and Bacteriology, University of Uppsala). The inhibitory effect upon *H* 37 *Rv* was studied only in Dubos' medium[4]; with the 1354 strain, the dilutions were made in different media: veal broth, Long's and Dubos' solutions. After the addition of the active filtrate to the substrate, the *p*H of the liquid was adjusted to about 7 with sodium hydroxide. The flasks with Dubos' medium were inoculated with a suspension of the bacteria, the other substrates with small floating pieces of the pellicle. Control flasks containing dilutions of the basal fungus nutrient solution were also seeded. The flasks were incubated at 37° C.

Dilutions of 1/3, 1/5 and 1/11 in Erlenmeyer flasks were used for routine tests. The flasks were examined at intervals of three days; but no visible growth could be detected in any medium after two months of incubation. In the controls the bacteria grew vigorously. Dilution experiments were also carried out in glass tubes, the growth being measured photometrically. After about three weeks a slight growth was found in the 1/50 dilution. In the tubes with the 1/30 dilution bacterial reproduction was completely inhibited (two months of observation). The two *Mycobacterium* strains tested behaved in a similar manner.

The antibacterial material has been separated from the culture medium in two different fractions, both showing an inhibitory effect against the two *Mycobacterium* strains. On distillation of the culture filtrate *in vacuo* (bath temperature 15° C.), a colourless, aqueous distillate of *p*H 6·5, showing activity, was collected in the receiver. The distillation was continued, while maintaining the volume in the distillation flask constant by adding water, until the distillate showed no activity. The aqueous distillate, containing the active principle, was extracted with small portions of ether or chloroform and the solvent removed under reduced pressure, leaving an oily, residue, soluble in ether, petroleum ether and chloroform, and fairly soluble in water. All the active material could not, however, be removed by distillation; the rest was extracted with ether from the culture medium left after distillation, the *p*H being adjusted to 1·5–2·5. The ether was removed under reduced pressure leaving an orange-yellow residue, not volatile but readily soluble in water, ether, chloroform and ethyl alcohol.

The *volatile* substance can also be isolated from the antibacterial filtrate by extraction with chloroform, which does not remove the *non-volatile* principle, or by adsorption on activated charcoal ('Norit'), followed by elution with chloroform or ether.

Aqueous and ethereal solutions, or a dry preparation of the *volatile* substance, undergo a chemical change on standing at room temperature, yielding an inactive, yellow residue, which is no longer soluble in water or ether. Stored at + 2° C., however, an aqueous solution can keep its activity for at least one month. Potassium permanganate solution and bromine water are decolorized by the substance in question, which also gives a precipitate with a mercuric chloride solution.

These preliminary investigations of the *volatile* substance indicate a certain resemblance to allicin, the antibacterial principle of *Allium sativum*[5,6]. As to the *non-volatile* substance, it can be extracted with ether only from acidified aqueous solutions. If it is kept at room temperature in a dry state or in solution, there is no appreciable change in its inhibitory effect for at least five weeks.

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GÖSTA WALLMARK

State Bacteriological Laboratory,
Stockholm.

KARIN ÖBLOM

Institute of Physiological Botany,
University of Uppsala.
March 5.

[1] Melin, E., Wikén, T., and Öblom, K., *Nature*, **159**, 840 (1947).

[2] Lindeberg, G., *Symb. Bot. Upsal.*, **8**, No. 2 (1944).

[3] Schmidt, W. H., and Moyer, A. J., *J. Bact.*, **47**, 199 (1944).

[4] Dubos, R. J., and Davis, B. D., *J. Exp. Med.*, **83**, 409 (1946).

[5] Cavallito, C. J., Buck, J., and Suter, C. M., *J. Amer. Chem. Soc.*, **66**, 1952 (1944).

Small, L. D., Bailey, J. H., and Cavallito, C. J., *J. Amer. Chem. Soc.*, **69**, 1710 (1947).

Utilization of Mineral Constituents of the Egg-shell by the Developing Embryo of the Stick Insect

THE presence of a relatively large quantity of mineral material, mainly calcium carbonate, in the egg-shell (exochorion) of Phasmidæ has been established by Pantel[1] (in eggs of *Donusa prolixa*). Extending his examinations to the egg content, Pantel found that the Malpighian tubules of fully developed embryos contained calcium salts far in excess of the quantity which he was able to demonstrate in the yolk of freshly laid eggs. Pantel interpreted this finding by assuming that most of the calcium in the yolk was organically bound and therefore not responsive to his methods of detection.

The egg-shell of *Bacillus libanicus* Uv. contains, besides calcium carbonate, also calcium oxalate and smaller quantities of aluminium, magnesium and potassium salts. Most of the calcium carbonate is concentrated in a white crystalline layer covering the inner surface of the shell. In freshly laid eggs, this white layer appears dense and opaque, its compactness and structure being the main cause of the rigidity of the egg-shell. It was observed that in the shells of fully developed or hatched-out eggs, the white layer is much reduced in thickness, the whole shell being less opaque and more brittle. A similar appearance could be produced in shells of freshly laid eggs by emptying them and immersing in water acidulated with carbon dioxide.

Considering these differences in thickness of the white layer, and in view of Pantel's observation, there arose the question whether during embryonic development mineral material from the egg-shell might not be passing into the egg-content. The possible occurrence of such a process in insect eggs was originally suggested by Needham[2], in view of the fact that in some avian and reptilian eggs utilization of egg-shell calcium by the developing embryo had been demonstrated[3,4].

To test this possibility, the quantities of ash in shells and in contents of eggs at various stages of development were determined and compared. As eggs laid by different females may vary considerably with regard to their ash content, only eggs of the same parentage were used for comparative measurements.

Material	% of ash in terms of dry weight in	
	Shells	Egg contents
Freshly laid eggs	38·4	0·7
Eggs entering diapause (age, 80 days)	35·4	1·1
Post-diapause eggs (10 days before hatching)	32·7	2·3
Eggs at hatching	30·8	3·5* (Neonate nymphs)
One-year old, undeveloped eggs	38·0	0·6

* The actual rise in ash quantity is somewhat lower, there being a corresponding decrease of about 6·4 per cent in the dry weight of the egg due to the development of the embryo.

The accompanying table summarizes some of the results concerning changes in the relative quantity (in terms of dry weight) of the mineral components in shells and in contents of developing and undeveloped eggs laid by one female. It shows clearly that in the shells of developing eggs the quantity of the mineral components decreases continuously, its percentage in dry shell weight diminishing by about 8 per cent; no such change is observable in shells of eggs which do not undergo development. Further, the quantity of the mineral material in the developing embryo rises markedly, there being no such rise in the undeveloped one-year-old eggs.

Thus it seems safe to conclude that during development of the egg of *B. libanicus*, a transfer occurs of mineral material from the egg-shell to the developing embryo. Although it was not possible to carry out a quantitative identification of the transferred minerals, the morphological observations mentioned above suggest that it is mainly calcium carbonate from the white layer of the shell that is absorbed by the embryo.

A more detailed account will be published elsewhere.

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Function of Hyaluronidase in Fertilization

Pincus[1] and Pincus and Enzmann[2] observed that the mass of follicle cells surrounding the freshly ovulated rabbit egg could be dispersed by means of sperm suspensions, and they inferred the presence of a proteolytic enzyme. Gilchrist and Pincus[3], describing the events taking place during *in vivo* fertilization in the rat, state that the freeing of adherent follicle cells is "an inevitable accompaniment of sperm penetration . . .". Afterwards, McClean and Rowlands[4] and Fekete and Duran-Reynals[5] produced evidence to show that the enzyme is probably hyaluronidase. They also expressed the view that the denudation of the egg is a necessary preliminary to the penetration of the sperm, and this theory, and the important role thus ascribed to hyaluronidase, have become widely accepted.

It should be noted, however, that Lewis and Wright[6] concluded from their investigations on the mouse egg that sperm penetrate to the vitellus "long before" the dissolution of the surrounding mass of follicle cells. Their evidence consisted chiefly in the finding of sperm in the perivitelline space of the freshly ovulated egg, and the extrusion of the second polar body when the eggs were kept in culture. They were, however, unable to observe pronuclei or sperm within the vitellus in their material. For some reason the evidence presented by Lewis and Wright appears to have been overlooked by the protagonists of the present concept of the function of hyaluronidase in fertilization.

During an investigation of fertilization in the rat, it has been observed that if females are killed when the copulation plug is found, the eggs are recovered in cumulus masses of varying degrees of integrity. Frequently the cumuli are indistinguishable under the microscope from those obtained from unmated rats. Nevertheless, most of the eggs show sperm within the vitellus, and when examined under the phase-contrast microscope, the male and female pronuclei can also be discerned. This means that an appreciable time, perhaps an hour or more, has elapsed since sperm penetration. In other cases, eggs observed in cumuli in varying degrees of disintegration show pronuclei of progressively greater size and more complex structure. It is clear, therefore, that in the rat the disintegration of the cumulus occurs over a period following fertilization.

A similar state of affairs appears to exist in the cat, for Prof. E. C. Amoroso (personal communication) has demonstrated the presence of sperm in the zona pellucida of the cat's egg while the latter was still surrounded by an apparently intact layer of follicle cells.

It is concluded that the penetration of the intact cumulus by the sperm as envisaged by Lewis and Wright does, in fact, occur, and that denudation of the egg, at least in some species, is not a prerequisite of fertilization. Clearly, therefore, the destruction of the cumulus prior to sperm entry is not an essential function of hyaluronidase, though the local presence of the enzyme may conceivably assist the passage of the individual sperm.

Illustrations of fertilized eggs in apparently intact cumuli, together with details of microscope technique, will be included in a full paper being prepared, in collaboration with Mr. J. Smiles, for submission to the *Journal of the Royal Microscopical Society*.

I wish to record my grateful acknowledgments to the Medical Research Council and Dr. C. R. Harington for the hospitality of the National Institute for Medical Research, Hampstead, and to Dr. A. S. Parkes and Prof. E. C. Amoroso for their valuable criticism and advice.

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Metabolism of Aminohydroxybenzoic Acids

WE have recently been studying the metabolism of some aminohydroxybenzoic acids. In view of the interest in these compounds which has been stimulated by the observations of Lehmann[1], Vallentin[2] and of Dempsey and Logg[3] of the beneficial effects of 4-aminosalicylic acid (*P.A.S.*) on patients with various tuberculous lesions, a preliminary statement of some of our results seems opportune.

We have already identified some aminohydroxybenzoic acids (or amides) as metabolites of aminobenzamides in the rabbit[4]; for example, 3- and 5-hydroxyanthranilic acids from *o*-aminobenzamide, 5-aminosalicylic acid from *m*-aminobenzamide and 4-amino-3-hydroxybenzoic acid from *p*-aminobenzamide. It is our intention to study the metabolism of the ten isomeric aminohydroxybenzoic acids, and so far we have carried out a preliminary examination of four, namely, 3-, 4- and 5-aminosalicylic acids and 3-amino-4-hydroxybenzoic acid. The three aminosalicylic acids appear to be metabolized by the rabbit in similar ways, being excreted partly unchanged and partly as acetamidosalicylic acids, all three of which have been isolated from the urine. No increase in ethereal sulphate excretion was observed. (Salicylic acid itself is not excreted as ethereal sulphate[5].) 3-Amino-4-hydroxybenzoic acid, however, does appear to be conjugated with sulphuric acid to a slight extent (about 4 per cent), as well as being excreted unchanged and as 3-acetamido-4-hydroxybenzoic acid.

Owing to its clinical interest and to the kind co-operation of Mr. D. E. Seymour, of Herts Pharmaceuticals, Ltd., in supplying us with the compound, we are examining 4-aminosalicylic acid in somewhat greater detail. In the rabbit, approximately 50 per cent of a dose of 1–2 gm. is excreted unchanged and 50 per cent as 4-acetamidosalicylic acid (m.p. 238–239°), which has been isolated and characterized. There has, so far, been no evidence of the formation of ethereal sulphate or of glucuronides of either ester or ether type. 4-Acetamidosalicylic acid has also been isolated from human urine after oral administration of 3 gm. sodium 4-aminosalicylate. Considerable amounts were excreted unchanged.

A fuller account of this work will be published elsewhere.

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Lipoid Content of the Oxyntic Granules of the Rat's Stomach

THERE have been a few suggestions in the literature that the granules of the oxyntic cells of the stomach might consist in part of a lipoid material. The evidence for this view has, up to date, been circumstantial, having been based on (*a*) the tendency of these granules to show some blackening after fixation in fluids containing osmium tetroxide[1], and (*b*) the assumption that, since they can be readily demonstrated by the Altmann – Regaud technique[2] and can be supravitally coloured by Janus Green *B* [3] they are mitochondria, and therefore contain lipoid.

Recently, more positive evidence for a lipoid component has been forthcoming. Foster[4], using a method by Baker[5], has shown that these granules have, in frozen sections of formol calcium chloride fixed rat's stomach, a strong affinity for Sudan Black (Fig. 1),

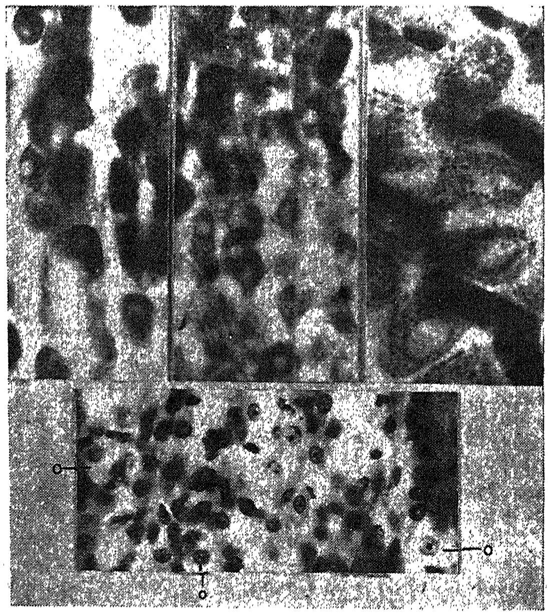

Fig. 1 Fig. 2 Fig. 3

Fig. 4

Figs. 1, 2 and 4. × 375. Fig. 3. × approx. 800. Fig. 4. O, OXYNTIC CELL. NOTE POSITIVE REACTION OF NUCLEI AFTER PYRIDINE EXTRACTION a fact strongly indicative of the presence of lipoid. I have confirmed these observations, and extended them by the use of Baker's acid hæmatin test[6] for lipines.

The oxyntic cells of the rat's stomach are strongly positive to the acid hæmatin test (Figs. 2 and 3) and therefore very probably contain lipine, although some oxyntic cells at the bases of the fundic glands are negative, showing only the unstained refractile granules. There is reason for believing that this is not a fixation artefact, or some similar effect, related to the technique employed, but that it represents a specific functional state of the cells in these positions.

After removal of the lipoids by the pyridine extraction method[6], the acid hæmatin test gave negative results (Fig. 4). It was quite clear, however, that the cells still contained refractile granules, comparable in numbers to those of the non-extracted cells, and it was possible to stain these with Heidenhain's iron hæmatoxylin. It seems reasonable to suppose, at this stage of the investigation, that these extracted granules consist partly of protein. If this is so, the oxyntic granules appear to be of a duplex nature, consisting of a protein core and a lipine (and perhaps non-lipine lipoid) envelope. In this respect they resemble not only mitochondria, but also the lipoid-invested vacuoles of the Golgi complex.

A preliminary study of the behaviour of these granules under certain experimental conditions that stimulate gastric secretion has shown (*a*) that in some cells there is a very marked enlargement of the granules, and an intensification of their positive reaction to acid hæmatin, and (*b*) that in others, perhaps the majority, there is a negative reaction to the acid hæmatin test, suggesting that in these cells the granules have lost their lipine component.

A full account of these and other observations on oxyntic and other chloride-secreting cells, their probable relation to mitochondria and the Golgi complex, and their possible relation to the mechanism of hydrochloric acid secretion, will be given elsewhere.

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Discriminating 'Athrocytes' in the Reticulo-endothelial System

'ATHROCYTOSIS' can be defined as the property of some types of cell (termed 'athrocytes') of absorbing and storing in granular form extraneous substances, mostly electronegative colloids. Lison[1] showed recently that the Kuppfer cells of the frog and toad liver do not all have this property to the same extent. Some—provisionally termed '*G*' cells—store certain electronegative dyes, namely, those in which the diameter of the particles is greater than 60–80 A. Others ('*F*' cells) accumulate preferentially those of smaller diameter. This behaviour is clearly seen when a frog is injected intraperitoneally with a mixture of two acid dyes the particulate diameters of which are respectively greater and less than 80 A.; for example, a mixture of soluble Prussian blue (228 A., calculated by means of Einstein's formula from the diffusion coefficient measured with a Nistler's diffusion microscope) and ammonium carmine (20·5 A.). In these conditions, the '*G*' Kuppfer cells take up only the blue, the '*F*' cells only the carmine.

Both cell types are 'discriminating athrocytes' according to the definition of Cordier, Gérard and Lison[2]: they select among the athrocytable substances, taking and storing some of them, neglecting the others. In this case, it was shown conclusively that the main factor controlling the selection is the dimension of the particle in solution (other types of discriminating athrocytosis have been described by Lison[3]).

The purpose of this communication is to present evidence of the existence of such discriminating athrocytes in the reticulo-endothelial system of mammals. The technique used in our experiments was the intraperitoneal injection into the rat of suitable mixtures of acid dyes. In contrast with the common practice in the investigations on the reticulo-endothelial system, one single injection was made, and the quantity of the dye injected was relatively small—in most experiments 0·01 gm. of each dye. Preliminary experiments showed that high doses of dyes and repeated injections result in strong reaction of the reticulo-endothelial system, involving mobilization of many cells and fundamental changes in the characteristics of its components. The dyes used were all non-dialysable electronegative dyes; and they can be divided into two groups: 'high-dispersion' dyes, for which the diffusion coefficient is less than $0\cdot050 \times 10^{-5}$ cm.^{2}/sec., corresponding to theoretical particulate dimensions less than 80 A.; and 'low-dispersion' dyes, for which the diffusion coefficient is greater than this value. This classification is merely a question of convenience and is adopted for reasons of clarity only.

The most striking results are obtained with mixtures of one 'high' and one 'low' dispersion dye. After one day, the two components appear to be nearly quantitatively separated and are found stored in granular form in different cells. The high-dispersion dye is accumulated in fine and medium-sized granules in elongated, spindle-shaped cells. These fixed cells are found throughout the connective tissue surrounding or penetrating the organs and must be regarded as 'histiocytes'. The low-dispersion component of the mixture is stored in medium- or large-sized granules in large polymorphous mobile cells with rounded or reniform nuclei. These cells, which are rather scarce in the common connective tissue, but are very numerous in the medullary of the lymphatic nodes and in the omentum, must be identified with 'free macrophages'. The greatest part of the dyes injected is found separately in these two cell types. In addition, a few cells store both components in the form of mixed granules. These cells, macrophagic in aspect, must be considered as transitional elements between histiocytes and macrophages for the following reasons: they occur in the regions where the production of free macrophages is intense, such as the medullary of the lymphatic nodes and the omentum: the granules are formed of various relative proportions of the two dyes, in such a way that all the transitions can be observed.

The high-dispersion dye appears in the histiocytes throughout the whole body, while the athrocytosis of the low-dispersion dye is restricted to the area near the point of injection, that is, in the abdominal and sometimes mediastinal lymphatic nodes, in the omentum, and in the connective tissue in the immediate neighbourhood of the abdominal cavity. It is evident that the resorption and the transportation of the low-dispersion dyes are much slower than those of the high-dispersion ones, resulting in a more restricted area of athrocytosis. It must be emphasized, however, that the storage of the two dyes in different types of cell is not the result of circulatory conditions, preventing the access of one dye to one type of cells, since both types of athrocytes can be seen in the same location closely packed together.

In the liver, also, the two dyes are found in separate cells. The Kuppfer cells selecting the high-dispersion dye are scattered equally in the whole lobule, while the cells which store the low-dispersion dye are restricted to the periphery of the lobule, near the interlobular veins. Thus the two types, '*G*' and '*F*', of the Kuppfer cells previously described in amphibians occur also in mammals, but their location is different.

When the two components of the mixture used in the previous experiments are injected separately their location is the same as if they were injected simultaneously.

When mixtures of two high-dispersion dyes are injected, the two components are not separated, but are stored in the same cells, mainly in the form of mixed granules; these findings are in accordance with the observations of von Möllendorff. When mixtures of two low-dispersion dyes are injected, the two components are found both in the same macrophages, sometimes in the form of mixed granules, more often in the form of separate granules; cells with only one component are not found.

The present experiments afford evidence that the athrocytes in the reticulo-endothelial system of mammals act selectively towards different substances, and that the main factor controlling the selection is the dimensions of the particle in solution. Therefore, substances of different dispersions are stored in different cell types, the critical value of the dispersion corresponding approximately to a diffusion coefficient of $0{\cdot}050 \times 10^{-5}$ cm.^{2}/sec.

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A Further Example of the Anti-*S* Agglutinin

A SECOND example of the human hæmagglutinin, anti-*S*, discovered by Walsh and Montgomery[1] has been identified. This agglutinin was shown by Sanger and Race[2] to be connected with the *MN* blood-group system, and to define either two more allelomorphs, *MS* and *NS*, at this locus, or else a second locus *S*, very closely linked to that for *M* and *N*. For practical purposes there is no difference between these two alternative possibilities.

The present example was found together with an anti-*D* agglutinin in the serum of a patient whose second pregnancy terminated in a stillborn hydropic fœtus at twenty-eight weeks gestation. The serum was first tested with a series of 48 *Rh* negative bloods, of which 22 were found to be agglutinated. It showed no relationship to *ABO*, *P*, Lewis or Lutheran blood groups, though there was suggestive evidence that it was connected with the *MN* groups, for, of the bloods of group *M*, eight were positive and five negative, and of those of group *N*, two were positive and six negative. Differential absorption was successfully achieved with three out of four *Rh* positive bloods chosen at random, the fourth donor removing all agglutinins.

The bloods of 250 unselected non-related people have been tested with the absorbed serum, and the results are given in Table 1 with the two previously published series. Dr. R. R. Race has also tested the bloods of 21 known *S* positive and 15 *S* negative individuals with the new serum, with complete agreement in all cases.

TABLE 1

	M		*N*		*MN*			
	S+	*S*−	*S*+	*S*−	*S*+	*S*−	Total	*S*+%
Walsh and Montgomery[1]	30	9	13	21	40	27	140	59·3%
Sanger and Race[2]	36	14	15	30	57	38	190	56·9%
Oxford series	55	20	12	33	67	63	250	53·5%
	28·28%		21·38%		50·34%		580	56%

A total of 580 bloods have now been tested with the two examples of the anti-*S* antibody, and the distribution of the *MN* groups is in good agreement with that expected in England. Prof. R. A. Fisher has very kindly recalculated the gene frequencies[3] for the combined data (Table 2).

TABLE 2

	S+	*S*−	Total
M	0·25585	0·27863	0·53448
N	0·08113	0·38439	0·40552
Total	0·33698	0·66302	1·00000

From these gene frequencies the expected genotype frequencies can be calculated (Table 3).

TABLE 3

Phenotypes		Genotypes	Expected	Observed	χ^2
M	*S*+	*MSMS* *MSM*	120·6921	121	0·0008
	S−	*MM*	44·9958	43	0·0885
MN	*S*+	*MSN* *MSNS* *MNS*	164·3819	164	0·0001
	S−	*MN*	124·2390	128	0·1139
N	*S*+	*NSN* *NSNS*	39·9928	40	0·0000
	S−	*NN*	85·6983	84	0·0337
			579·9999	580	0·2370 d.f. 2 $p = 0{\cdot}9$

It will be seen that the agreement between the calculated figures and those actually observed is very close indeed, and provides additional evidence of the correctness of the genetical interpretation of Sanger and Race.

The blood groups of the family are as follows:

Mrs. M.G.	Group *A* R'' (*cdE*/*cde*) *M* *S*− Lutheran− Lewis−
Mr. G.	Group *O* R_1R_2 (*CDe*/*cDE*) *MN* *S*+ Lutheran− Lewis−
C. G., son	Group *A* *Rh*+ *M* *S*+
Stillborn infant	Group *A* *Rh*+ Direct Coombs' Test + + +

The anti-*S* titre of the serum rose from 1 : 1 three days before delivery to 1 : 16 three weeks after delivery, and by six weeks *post partum* had fallen to 1 : 8. The antibody was active at 37° C. and 20° C., though slightly more intense reactions were obtained at 37° C. The thermal range and the familial incompatibility of *S* groups suggest that this is an immune agglutinin, though the presence of the anti-*D* agglutinin (titre 1 : 16) does not allow of any evaluation of the part it may have played in fœtal morbidity. It is unlikely that the agglutinin has been previously encountered in this laboratory, as the donor of the *Rh* negative cells which were first found to be agglutinated by this serum has been one of the standard *Rh* negative controls for antibody investigations since 1943.

I should like to thank Dr. R. R. Race for his interest and advice, and Mr. J. A. Morton and Mr. W. Penfold for technical assistance.

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Variations in Spermatogenesis of Oligospermic Men

Zondek, Bromberg and Polishuk have suggested[1] that oligospermia in men can be divided into two types, constant and periodic; and that it is only men in the latter group who are likely to produce pregnancies. While agreeing that individuals differ in the range of variation of their sperm counts, we do not think this is either a clear-cut or a useful distinction.

It is, of course, impossible to draw conclusions about the reaction of a patient to treatment for oligospermia unless several specimens have been examined before treatment is given. It is also essential that specimens for comparison should have the length of the period of abstinence since the previous ejaculation controlled in both directions. Zondek *et al.* give only a minimum of length of interval. An interval of two or three weeks may result in sperm counts five times as high as those obtained after three to five days. As the number of motile spermatozoa does not increase with a long interval to anything like the same extent as does the total number of spermatozoa present, and as their viability is frequently impaired, the increase in sperm density cannot be regarded as improving the chances of fertilization. A possible cause of apparent periodic oligospermia is the occasional loss of the first few drops of the ejaculate, the majority of the spermatozoa being in the first fraction[2]. In our experience this is often the cause when men, whose sperm density is usually more than 60 million per c.c., produce specimens with counts less than 20 million.

Case	Sperm densities (M./c.c.)	Corresponding interval since previous ejaculate (days)
I	0·4, 1·0, 0·1, 0·2	3, 3, 3, 3
II	5, 3, 5, 4, 5, 10, 2, 5	3, 4, 3, 7, ?, 13
III	10, 6·5, 6·5	5, 4, 2
IV	8, 2	11, 3
V	6, 5, 17	2, 8
VI	1·5, 0·5	28+, 2
VII	1·5, 1·5, 1·0, 2·0, 0·65	?, 8, 4, ?, 4

It is not necessary to postulate periodic, as opposed to constant, oligospermia to explain pregnancies in wives of oligospermic men. The lower limits of sperm count usually stated as necessary for fertilization are definitely too high. In a series of more than seven hundred sub-fertile marriages, seven women whose husbands constantly had sperm densities less than 20 million per c.c. have conceived. Details are given in the accompanying table. In cases II–V conception took place shortly after the last semen analysis; in case I the last count was done a month after conception occurred. Cases VI and VII are less convincing, as conception did not take place until more than a year after the patients stopped attending the clinic, and the husbands may have improved in the interval. A further seven conceptions occurred in women whose husbands had, in a single seminal analysis, sperm densities less than 20 million per c.c.

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Relation Between Fountain Pressure and Heat Current in Helium II

Allen and Reekie[1] directed attention to the fact that the fountain-pressure difference ΔP at the ends of a narrow slit or capillary produced by a temperature difference is, in the absence of mass flow, exactly proportional to the heat current W appearing simultaneously with the fountain pressure.

For very narrow slits (up to 10^{-4} cm.) the heat current is proportional to the temperature difference at all temperatures up to the immediate neighbourhood of the λ-point. For wider slits (greater than 10^{-3} cm.), the linear relation between heat current W and temperature difference ΔT changes gradually over to proportionality between W and the cube root of ΔT. These deviations from linearity are greater for wider slits, and for higher temperatures and greater gradients at any constant slit width.

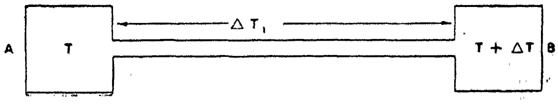
Keesom and Duyckaerts[2] and Mellink[3] confirmed that the Allen – Reekie proportionality between fountain pressure ΔP and heat current W is retained no matter what the relation between W and ΔT, including the regions where this dependency approaches the cube root law.

This is difficult to understand so long as the factors responsible for the deviation from linearity between W and ΔT are regarded as operative in the slit itself where the fountain pressure gradient must exist.

A simple explanation can be given in terms similar to the model proposed recently[4] for the anomalous mechano-caloric effects in the super-critical mass flow of helium II through slits.

The experimental arrangement for measuring W and ΔP may be represented schematically as in the accompanying figure.

A narrow slit of from 0·1 to 20 μ, or a capillary filled with emery powder, connects two temperature



baths A and B containing bulk liquid at temperatures T and $T + \Delta T$ respectively.

The anomalous heat effects accompanying mass flow could be explained by the assumption that the temperature difference ΔT between A and B is greater than the temperature difference ΔT_1 between the ends of the slit itself, if the velocity of the particles emerging from the slit (or entering the slit) is greater than the critical velocity of the superfluid flow.

In the present problem there is no net mass flow. But according to L. Tisza and F. London[5], the heat flow in a narrow slit can be considered as a viscous back-flow of normal particles under the fountain-pressure difference. The velocity u of the normal (excited) particles can be estimated from the equation $W = \rho Q u$, where ρ is the density and Q the heat content of helium II. u is actually about equal to the critical velocity for values of W in the region where the first deviations occur from the linear relation between W and ΔT. These deviations from linearity may thus be due to the appearance of temperature differences $\Delta T_b = (\Delta T - \Delta T_1)$ in the bulk liquid near the ends of the slit, caused by the normal particles emerging from the slit at a velocity higher than the critical one.

The fountain pressure can only depend on the temperature difference ΔT_1 between the ends of the slit itself. For narrow slits it obeys the relation given by H. London[6],

$$\Delta P = \rho S \, \Delta T_1, \tag{1}$$

and generally (see S. R. deGroot[7])

$$\Delta P = k_f \, \Delta T_1, \tag{2}$$

where k_f falls to lower values than ρS for capillaries of such a width that some excited particles can also pass, and the heat of transportation Q^* is less than TS.

The heat current, on the other hand, depends on the total temperature difference $\Delta T = \Delta T_1 + \Delta T_b$; but the thermal resistance consists of two resistances in series, namely, the resistance in the bulk adjacent to the ends of the slit, and the resistance in the slit. It is assumed that W is proportional exactly to ΔT_1 within the slit in accordance with the model of viscous back-flow, and that all deviations from linearity are due to the resistance in the bulk liquid. From the fact that the heat flow in wide tubes is proportional to $(\Delta T)^{1/3}$, we may assume the same dependency to be valid for the resistance in the bulk liquid.

The condition for continuity of heat flow states that

$$W = k_1 \, \Delta T_1 = k_2 (\Delta T_b)^{1/3}, \tag{3}$$

with

$$\Delta T = \Delta T_1 + \Delta T_b.$$

Comparing the first part of (3) with (2) yields exactly the Allen – Reekie relation

$$W / \Delta P = k_1 / k_f = \text{constant}. \tag{4}$$

This result holds no matter what the relative importance of the different series resistances, remaining true even when the heat current follows almost the cube root law. Thus for wider slits the fountain pressure may be very small because $\Delta T_1 \ll \Delta T$, so that $\Delta T \doteqdot \Delta T_b$ and W is almost exactly proportional to $(\Delta T)^{1/3}$; for narrower capillaries the fountain pressure and ΔT_1 both become appreciable, so we get values intermediate between linearity and the cube root law. For the narrowest slits the fountain pressure assumes its maximum value, $\Delta T = \Delta T_1$, $\Delta T_b = 0$, because the particles emerge from the slit at velocities smaller than the critical one and no temperature gradient appears outside the ends of the slit. So W is now exactly proportional to ΔT.

In consequence of this interpretation, the transition probability relation derived by us previously to account for the cube root law[8] can hold only in the bulk liquid, and not in very narrow slits or capillaries. The proximity of the wall apparently inhibits the relaxation effects, a circumstance which is probably related with the fact that the superfluidity of helium II appears near walls and in narrow slits.

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May 19.

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High-Frequency Resistance of Superconductors

MEASUREMENTS of the high-frequency resistance of superconducting tin, extending previous work[1] at 1,200 Mc./s., have now been carried out at frequencies around 9,200 Mc./s. (wave-length 3·2 cm.). The experimental technique is in principle the same as at 1,200 Mc./s., with the twin-wire resonator replaced by a half-wave coaxial resonator. The variation of the resistivity, R, with temperature is shown in the accompanying graph, together with the results of the earlier measurements for comparison. For convenience, R is expressed in terms of the resistivity, R_n, of normal tin just above the transition temperature. The experimental points plotted are those taken with one of the five specimens actually measured; the points for the other specimens are in close agreement.

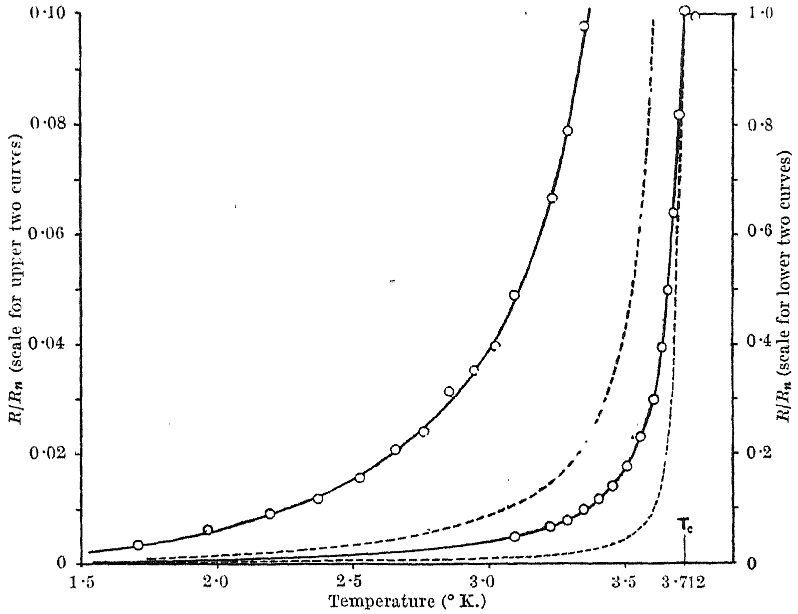
If the usual assumption[2] be made that a superconductor contains both 'superconducting' and 'normal' electrons, which react independently to an applied field, certain predictions about the frequency-variation of r $(= R/R_n)$ may be made by means of general arguments. In the first place, it may be shown that the initial slope dr/dT, just below the transition temperature, T_c, should vary with frequency as $\nu^{-2/3}$. The experimental results are not in agreement with this prediction. For the two frequencies used, the ratio of the slopes is 2·95 instead of the predicted 3·9.

It may further be shown that at temperatures sufficiently far below T_c that $r \ll 1$, the resistivity R at a given temperature should vary as ν^2. A separate experiment has shown that $R_n \propto \nu^{2/3}$, in accordance with the theory of the anomalous skin effect[3], so that it would be expected that $r \propto \nu^{4/3}$ at any temperature well below T_c. It may therefore be predicted without any but general arguments based on the model that, for $r \ll 1$,

$$r = A f(T), \tag{1}$$

where

$$A \propto \nu^{4/3}. \tag{2}$$



RESISTIVITY OF SUPERCONDUCTING TIN: FULL LINES, AT 9,200 Mc./s.; BROKEN LINE, AT 1200 Mc./s. THE UPPER CURVES ARE ON TEN TIMES THE SCALE OF THE LOWER CURVES

Now it has been found empirically that for $T < 3{\cdot}3°$ K. the experimental curves for both frequencies, in agreement with equation (1), are closely fitted by the expression

$$r = A' \cdot \frac{t^4(1 - t^2)}{(1 - t^4)^2},$$

in which t is the reduced temperature T/T_c.

The experimental values of A', however, show a marked departure from the frequency-variation of equation (2). Thus, $A' = 0{\cdot}0195$ at 1,200 Mc./s., and 0·0865 at 9,200 Mc./s.

The ratio of these two values, 4·43, is very different from the predicted ratio of 15·12. A discrepancy of this magnitude cannot be accounted for by observational errors, and it must be concluded either that some relevant factor has been omitted from the general arguments, or that an incorrect model has been used. Further experiments are in progress to discover the cause of these anomalies, and the measurements are also being extended to mercury, which appears from preliminary results to exhibit similar anomalies, though to a lesser extent.

A full account of this investigation will be published elsewhere.

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Oxidation of Uranium Dioxide (UO_2)

IN connexion with earlier investigations on uranium oxides in this Institute, it was observed that uranium dioxide (UO_2) can react with oxygen at so low a temperature as 120° C. To obtain more exact information about this low-temperature oxidation of UO_2, the oxide was heated in purified oxygen at different temperatures from 100° to 265° C. and the reaction products examined by the X-ray powder method[1].

At 150° C., UO_2 takes up oxygen at least to the composition $UO_{2{\cdot}34}$. This oxidation causes a displacement of the X-ray interference fringes and a broadening of some of them, indicating a change to lower symmetry. As an approximation the lattice of the new structure was considered to be cubic. A specimen with the composition $UO_{2{\cdot}34}$ was found to have the lattice constant $a = 5{\cdot}40$ kX. (for UO_2, $a = 5{\cdot}468$ kX.). It is difficult to decide whether or not the structure of UO_2, the β-phase, changes continuously as the oxygen content increases. If the change is discontinuous, the two structures belong to different phases.

The experimentally found density of UO_2 is 10·80 gm./c.c. and of $UO_{2{\cdot}34}$ 11·05 gm./c.c. The increase of the density from UO_2 to $UO_{2{\cdot}34}$ can only be explained by the assumption that oxygen, at least partly, enters into interstitial positions of the UO_2 lattice. Nevertheless, the lattice contracts; this must be due to the fact that the expected increase of lattice dimensions due to interstitial addition of oxygen is overcompensated as some of the uranium ions change their charge from + 4 to + 6 (or + 5).

By raising the temperature to 200°–250° C. the oxygen content exceeds the formula $UO_{2{\cdot}34}$, and another new phase, the δ-phase, is formed. X-ray photographs indicate that the δ-phase has a narrow range of homogeneity around $UO_{2{\cdot}40}$. The phase is found to be tetragonal, a specimen with the composition $UO_{2{\cdot}43}$ having the following lattice constants: $a = 5{\cdot}37$ kX., $c = 5{\cdot}54$ kX. and $c/a = 1{\cdot}03$.

TABLE 1. CALCULATED DENSITIES OF THE δ-PHASE

Phase	Formula	Density in gm./c.c.
AB_2-addition	$UO_{2{\cdot}43}$	11·46
AB_2-substitution	$U_{0{\cdot}88}\,O_{2{\cdot}12}$	10·04
AB_2-subtraction	$U_{0{\cdot}82}\,O_2$	9·44

Table 1 gives the densities calculated for a preparation with the composition $UO_{2{\cdot}43}$ if the lattice is derived from that of UO_2 by: (1) addition of oxygen; (2) substitution of uranium with oxygen; or (3) subtraction of uranium. On comparing these densities with the observed one, 10·00 gm./c.c., only assumption (2) provides agreement between observed and calculated values. The lattice of the δ-phase must then be regarded as derived from that of UO_2 by substitution of uranium with oxygen. The formula of the specimen $UO_{2{\cdot}43}$ must therefore strictly be written $U_{0{\cdot}88}\,O_{2{\cdot}12}$.

The intensities of the X-ray interference fringes indicate that the uranium atoms form a face-centred lattice $(000\,;\ 0\,;\ \frac{1}{2}\frac{1}{2}0\frac{1}{2}\,;\ \frac{1}{2}0\frac{1}{2}\frac{1}{2})$. In Table 2 intensities are calculated for the uranium atoms in the usual way, including corrections for absorption, but without temperature factor. Observed and calculated intensities are in good accord.

TABLE 2. OBSERVED AND CALCULATED INTENSITIES ON POWDER PHOTOGRAPH OF $UO_{2.43}$. IRON K RADIATION

h k l	$I_{obs.}$	$I_{calc.}$	*h k l*	$I_{obs.}$	$I_{calc.}$
111	st.	5·2	313	st.	5·9
002	w.	1·0	331	m.	3·0
200	m.	2·0	204	st.	3·1
202	st.	3·1	402		3·1
220	w.	1·5	420		3·2
113	m.	2·6	224	m.	4·0
311	st.	5·2	422	v.st.	8·7
222	m.	2·6	115	m.	5·4
004	v.w.	0·7	333	st.	6·4
400	v.w.	1·3	511	v.st.	14·0

The existence of a uranium oxide with the composition U_2O_5 has often been assumed, and recently by R. Lydén[2], who prepared it by the action of potassium hydrogen carbonate on U_3O_8. In the tensimetric phase diagram of W. Biltz and H. Müller[3], an oxide U_2O_5 had no observable range of existence. In our investigations, however, a phase near the composition U_2O_5 was found; but the oxide exists only at temperatures below 260–270° C. as a tetragonal deformed substitutional UO_2 phase and has a composition which does not seem to exceed the formula $U_{0.88}\ O_{2.12}$.

X-ray photographs of products prepared according to Lydén exhibit a slightly modified U_3O_8-structure. The products were found to have a composition in the region of $UO_{2.60}$ although approximately a third of the uranium had gone into solution. By reduction of U_3O_8 with hydrogen at 330° C., similar X-ray photographs were obtained, indicating that U_3O_8 has a range of homogeneity between $UO_{2.67}$ and $UO_{2.56}$.

P. Jolibois[4] has recently published results on the oxidation of UO_2 which also show the existence of a phase with a composition close to U_3O_7 ($UO_{2.33}$) but without giving further information on the properties of this phase.

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Crystal Structure of Uranium Oxide (U_3O_8)

THE uranium oxide U_3O_8 can be obtained by heating UO_2 as well as UO_3 in air or oxygen to red heat. So far as we know, however, no determination of the structure of this oxide has been published; the difficulty in preparing single crystals of U_3O_8 may be the reason.

While preparing UO_2 crystals, F. W. Hillebrand[1] got some small green-olive-greyish crystals. They seemed to be orthorhombic and were perhaps U_3O_8 crystals. V. M. Goldschmidt and L. Thomassen[2] reported that U_3O_8 did not crystallize regularly.

We did not succeed in preparing U_3O_8 single crystals; but one of the preparations gave X-ray photographs on which reflexions with indices $00l$ only were sharp and well defined, and this has enabled us to put forward a hypothetical crystal structure. All lines on the X-ray photographs can be identified as belonging to an orthorhombic cell with the dimensions: $a = 6{\cdot}703$ kX., $b = 3{\cdot}969$ kX., and $c = 4{\cdot}136$ kX.

The density of U_3O_8 was found pycnometrically to be 8·34 gm./c.c. On comparing this density with those calculated under different possible assumptions as given in Table 1, one finds for U_3O_8 that with three uranium atoms in the elementary cell the density is not in agreement with that observed. The observed density is only compatible with U_3O_8 as an AB_3 subtractive phase (or an AB_2 interstitial phase). The elementary cell then contains two uranium atoms.

TABLE 1. CALCULATED DENSITIES OF U_3O_8

Phase	Formula	Mol.	Density in gm./c.c.
$AxBy$	U_3O_8	1	12·63
AB_3-addition	$U_{1.12}\ O_3$	2	9·46
AB_3-substitution	$U_{1.09}\ O_{2.91}$	2	9·18
AB_3-subtraction AB_2-addition	$UO_{2.67}$	2	8·42
AB_2-substitution	$U_{0.82}\ O_{2.18}$	2	6·88

Here we will not give a general discussion of the space groups which can be considered, but only state that the intensities of the lines on the X-ray photographs indicate the uranium atoms to have the positions a : 000, b : $\frac{1}{2}\frac{1}{2}0$. The arrangement of the atoms may then be referred to the space-groups D_{2h}^{19}, D_{2h}^{13}, D_{2h}^{9}, D_{2h}^{7}, D_{2h}^{5}, D_{2h}^{4}, D_{2}^{6}, C_{2v}^{14}, C_{2v}^{11}, C_{2v}^{8}, C_{2v}^{6}.

The observed intensities were estimated visually. Intensities were calculated in the usual way, including corrections for absorption in the powder rod, but without the temperature factor. The structure factor was calculated for the uranium atoms only. As seen from Table 2, observed and calculated intensities are in good agreement.

TABLE 2. OBSERVED AND CALCULATED INTENSITIES ON POWDER PHOTOGRAPH OF U_3O_8. IRON K RADIATION

h k l	$I_{obs.}$	$I_{calc.}$	*h k l*	$I_{obs.}$	$I_{calc.}$
001	m.	2·1	402	m.	1·8
110	m.	3·3	130		1·8
200	w.	1·6	420	st.	1·8
111	m.	5·4	113		3·7
201	w.	2·7	203		1·8
002	w.	1·1	510	w.	1·8
020	w.	1·0	131	m.	3·9
310*	m.	2·1	421	w.	3·9
021	w.	1·9	511*	m.	4·0
112	v.st.	3·6	330	w.	2·5
311		3·6	023	w.	2·6
202		1·8	313	m.	5·2
220	w.	1·7	600	v.w.	1·3
400	v.w.	0·9	132	st.	5·6
221	m.	3·4	331		5·6
401	v.w.	1·7	422	m.	6·0
022	w.	1·6	512	m.	6·1
312	m.	3·2	601		3·0
003	v.w.	0·9	223	m.	6·7
222	m.	3·5	403	w.	3·5
			004[1]	m.	2·3

* Coincides with β-reflexions.

Oxygen ions scatter X-rays so slightly that with visually observed intensities we cannot draw conclusions regarding their positions. It is probable, however, that the U_3O_8 structure is related to the ReO_3 structure, but with deformed UO_6^{-4} octahedrons with anion vacancies. If the distribution of these vacancies is statistical, the cell already mentioned can be considered as the elementary cell, or else it would be larger. The ReO_3 structure type is, according to K. Meisel[4], the highly symmetrical form of an AB_3 structure, with which the CrO_3, MoO_3 and the WO_3 structures[5] are also closely related.

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Structure of Abraded Surfaces

The importance of surface conditions in the fatigue of metals and alloys has led to an investigation in this Laboratory into the effect of abrasion on the hardness and microstructure of surface and sub-surface layers.

Hardness measurements were made with a 'Tukon' microhardness tester and a load of 25 gm. on metallographically polished 2° taper sections prepared in a manner described by Nelson[1], and more recently by Moore[2], except that the bulk of the metal was used as a backing for the hardness impressions instead of thin wedges. The mechanical magnification obtained was of the order of 20, thus allowing hardness impressions to be spaced at effective distances of 0·5 μ below the surface.

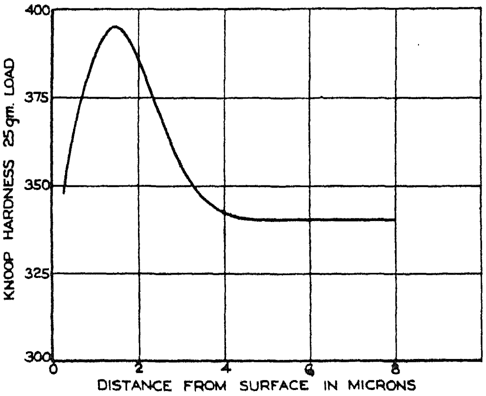

Fig. 1

In the case of chromium-molybdenum steel, heat-treated to a uniform sorbitic structure and to an average bulk hardness of Knoop 340, it was found that abrasion caused an increase in hardness in the surface layers to a depth of 3·5–6 μ according to the degree of abrasion. The maximum hardness obtained was approximately constant at Knoop 400 and occurred at a depth of 1·5 μ in all cases (Fig. 1). However, the most notable feature of the curves of hardness against depth was the fact that the hardness increase diminished progressively from a depth of 1·5 μ to the surface.

Metallographic examination of the taper sections at high magnifications (× 2,500) revealed a layer, corresponding in thickness to the depth of 'softening', in which a modification of the original structure of the steel was evident. Similar structural changes have been observed by Wulff[3] and his associates, in stainless steel, and by Benard, Lacombe, and Chaudron[4], in 'Armco' iron, and have been explained as being due, principally, to the plastic deformation accompanying abrasion. However, the 'softening' effect in the surface layers of steel specimens used in this investigation indicated that plastic deformation cannot be responsible for all the effects observed. The probable cause for this 'softening' was tempering or recrystallization due to the frictional heat of the abrading process, since decarburization of the surface was proved to be absent, and structural alteration during the polishing of the sections was overcome by using a polish-etch technique.

To obtain further information on this point, a series of severely abraded alpha-brass samples (containing 35 per cent zinc) were sectioned after various annealing treatments at temperatures up to 350° C. In the unannealed specimen, the hardness curves were of the same form as previously described, while metallographic examination revealed a layer of fine crystallites at the surface extending to a depth of 1–2 μ (Fig. 2), followed by a deformed layer to a depth of 35 μ. The crystallites were resolved at a magnification of 2,500, the average size being 0·5–1 μ (Fig. 3). No change from the above microstructure was observed in specimens annealed up to 240° C., but annealing at 249° C. caused an increase in the depth of the layer of fine crystallites, indicating that recrystallization of the deformed sub-surface layers had commenced (Fig. 4).

The similarity between the structure obtained by recrystallization of the deformed layers on annealing, and that existing in the extreme surface layer of the unannealed specimen, indicated that the 'softening' observed was due to recrystallization during abrasion. Annealing at still higher temperatures produced considerable grain-growth in the already recrystallized zones and progressive recrystallization into the more lightly deformed regions.

It is concluded from these experiments that, during abrasion, the temperature of the extreme surface layers is raised sufficiently to cause recrystallization. It has further been shown that recrystallization in an alpha-brass, containing 35 per cent zinc, when deformed as in abrasion, occurs at a temperature of 249° C. with the formation of crystallites of approximately 10^{-4} cm.

These results are important in relation to the failure of metals by fatigue. Since fatigue cracks normally start at the surface, the recrystallized and deformed layers produced by surface grinding should be removed before testing, to ensure that endurance curves characteristic of the material are obtained.

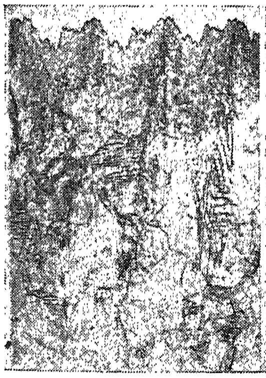

Fig. 2

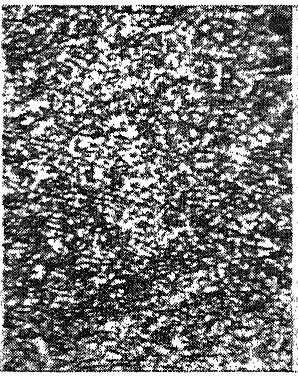

Fig. 3

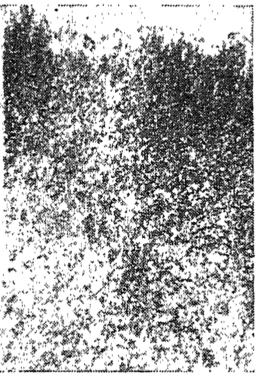

Fig. 4

Fig. 2. STRUCTURE OF UNANNEALED BRASS SPECIMEN. × 150

Fig. 3. STRUCTURE OF SURFACE LAYER. × 1,500

Fig. 4. STRUCTURE OF ANNEALED BRASS SPECIMEN. × 150

The work described above was carried out as part of the programme of the Metallurgy Section, Division of Aeronautics, Council for Scientific and Industrial Research.

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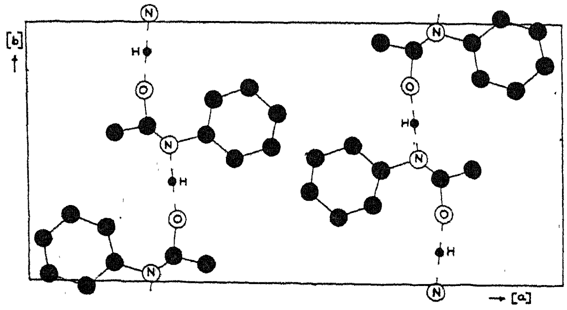
Crystal Structure of Acetanilide: Use of Polarized Infra-Red Radiation

THE crystal structure of acetanilide has been determined[1] by classical X-ray diffraction methods, making use of information derived from polarized infra-red radiation technique as a time-saver in the trial-and-error process. The crystals from water or ethanol vary in form from plates {100} to truncated bipyramids {111}, but growth from the molten state results in acicular crystals, elongated along [*b*] and tabular on (100). The orthorhombic unit cell contains eight molecules and has dimensions:

$[a] = 19{\cdot}50$, $[b] = 9{\cdot}46$ and $[c] = 7{\cdot}96$ A.; space group $Pbca - D_{2h}^{15}$.

Utilizing available data regarding cleavage and optical properties[2], a three-dimensional molecular model was constructed which was expected to represent the most probable arrangement within the unit cell, and which would normally have been used as a starting-point for preliminary trial-and-error calculations of structure amplitudes. Simultaneously, experiments with polarized infra-red radiation were being conducted by Crooks[3] which yielded information concerning the directions of the C_6H_5—N, N—H, C=O and C—CH_3 bonds, as well as indicating the relative orientations of the benzene rings. The rough molecular model was adjusted slightly to take these new data into account, and from the measured atomic parameters, the first thirty or forty structure amplitudes calculated showed remarkably good agreement with the experimental values.

X-ray intensities were obtained from Weissenberg photographs taken about the zero-levels of the [*b*]- and [*c*]-axes, and from single-crystal oscillation photographs about the [*c*]-axis. Refinement of the structure was effected by means of Fourier projections on (010) and (001) and by means of appropriate lines and sections of a three-dimensional synthesis, with the result that the phases of about three hundred structure amplitudes are now known with certainty. The structure is depicted in the accompanying diagram; bond-lengths appear to be within the accepted values; the length of the hydrogen bond distance N—H—O is 2·9 ± 0·1 A. It is hoped that further refinement will be carried out later; but since this is by no means certain, the following list of co-ordinates is here placed on record.



ARRANGEMENT OF MOLECULES IN UNIT CELL BETWEEN $z = 0$ AND $z = 1/2$. THE OTHER FOUR MOLECULES IN THE CELL MAY BE OBTAINED BY REFLECTING THESE FOUR ACROSS THE PLANE $y = 1/4$ AND GLIDING THEM $c/2$

	X	*Y*	*Z*
C_1	0·16	0·07	0·12
C_2	0·11	0·98	0·17
C_3	0·04	0·02	0·14
C_4	0·03	0·16	0·06
C_5	0·08	0·25	0·01
C_6	0·15	0·21	0·04
N	0·23	0·03	0·15
C_7	0·27	0·10	0·25
O	0·28	0·24	0·30
C_8	0·33	0·07	0·29

The use of polarized infra-red radiation promises to be of great assistance in crystal structure determinations, but further trials with more complex substances will be necessary before a full assessment of its value can be made. It is probable that the infra-red technique will require further development so that small single crystals may be used. In some work with crystals containing water of crystallization it has been found that strong water-bands tend to obscure that part of the spectrum which would yield most information, but it is expected that more complete polarization would enable this difficulty to be overcome. In a crystal where several similar bonds are distributed in different directions, it may not prove possible to analyse the results adequately without a considerable increase in sensitivity of the infra-red apparatus.

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March 22.

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[1] Report of Institute of Physics X-Ray Analysis Conference, 1947, *J. Sci. Instr.*, 25, 90 (1948).

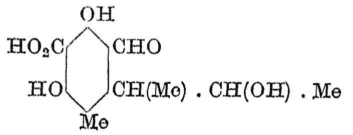
[2] Winchell, A. N., "Optical Properties of Organic Compounds" (Wisconsin, 1943).

[3] Crooks, D. A., *Nature*, 160, 17 (1947).

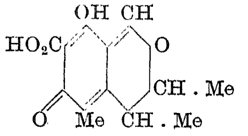
Structure of Citrinin

IN view of the recent communication on this topic by Cram[1] to the editor of the *Journal of the American Chemical Society*, we wish to record that in the course of an extensive investigation on the chemistry of citrinin initiated in these laboratories in 1945, the synthesis of 4-methyl-5-ethylresorcinol[2], m.p. of anhydrous material 94–95°, was effected in 1946, and the orientations of the two isomeric phenols '*A*' and '*B*' $C_{11}H_{16}O_3$ afterwards established. From these results, *inter alia*, together with a study of the degradation products of methylated citrinin and of dihydrocitrinin and its ether, evidence has accumulated which leads to the conclusion that citrinin in all probability is best represented by the expression (II).

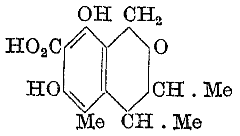
The claims of competing structures, including those of the quinol (*cyclo*hexadienolone) type, have been considered; but so far as our evidence goes it would seem that formula (II), which is an anhydro



I



II



III

form of (I), most satisfactorily explains (*a*) the ready aromatization of the compound in warm acid or alkaline media with the extrusion of formyl (as formic acid) and carboxyl (as carbon dioxide) groups; (*b*) the formation of formic acid and not formaldehyde or glyoxylic acid on the ozonolysis of citrinin and its ester; and (*c*) the formation of a stable dihydro derivative (III) with simultaneous aromatization. The structure (III) ascribed to the latter compound is in agreement with its blue ferric reaction, which is characteristic of γ-resorcylic acids. On the basis of formula (II), the phytochemical formation of citrinin may conceivably proceed by way of the intermediate (I).

It would seem that the claim by Cram[1], that the isolation of authentic 4-methyl-5-ethylresorcinol from citrinin completely eliminates the formula proposed for the latter by Robinson *et al.*[3], can scarcely be sustained at present. The above formula retains the original suggestion of a hemi-quinone type of kernel.

J. P. BROWN
N. J. CARTWRIGHT
A. ROBERTSON
W. B. WHALLEY

Department of Organic Chemistry,
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[1] Cram, *J. Amer. Chem. Soc.*, **70**, 440 (1948).

[2] Compare Brown, M.Sc. Thesis, May 1947, University of Liverpool.

[3] Robinson *et al.*, *Phil. Trans. Roy. Soc.*, B, **220**, 297 (1931).

Nitration of Simple Heterocycles

IN a recent letter in *Nature*[1], Schofield and Swain comment, *inter alia*, upon the failure of resonance theory to explain non-nitration of *iso*quinoline in position 7: the following results may be of interest.

In the course of work in these laboratories we have been led to investigate the nitration products of 3 : 4-dihydro*iso*quinoline derivatives and have found, for example, that 1-*p*-nitrophenyl-3 : 4-dihydro*iso*quinoline gives an 80 per cent yield of the 7-nitro derivative, this structure being proved by comparison with the product of cyclization of N-*p*-nitrobenzoyl-2-(4′-nitrophenyl)ethylamine. On the other hand, 1-*p*-nitrophenyl*iso*quinoline yields 85 per cent of 1-*p*-nitrophenyl-5-nitro*iso*quinoline, identified by conversion to 1-*p*-chlorphenyl-5-chlor-*iso*quinoline and comparison with a synthetic sample. Such substitution in the *iso*quinoline ring may be compared with that of quinoline which is nitrated in the 5 and 8 positions, whereas tetrahydroquinoline has been shown to nitrate in position 7 [2], a result compatible with expectation since *o*-toluidine yields 4-nitro-2-aminotoluene[3]. Similarly, *iso*quinoline is nitrated principally in the 5 position with a small proportion of the 8-isomer[4]. Nitration of reduced *iso*quinoline has escaped attention, and investigation of the products of nitration of 3 : 4-dihydro- and 1 : 2 : 3 : 4-tetrahydro*iso*quinoline is now being undertaken, when we expect to isolate the 7-nitro derivatives in accordance with the above result and by comparison with the nitration of *o*-cyantoluene, which yields 4-nitro-2-cyantoluene[5], and of 2-phenylethylamine, which has been shown to give 45 per cent of the para and 18 per cent of the meta isomer[6]. Results will be reported in detail elsewhere.

We wish to thank the directors of May and Baker, Ltd., for permission to publish these results.

DAVID W. MATHIESON
A. MCCOUBREY

Research Laboratories,
May and Baker, Ltd.,
Dagenham, Essex. May 5.

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[1] *Nature*, **161**, 690 (1948).

[2] Hoffmann and Königs, *Ber.*, **16**, 736 (1883). v. Braun, Grabowski and Rawicz, *Ber.*, **46**, 3173 (1913).

[3] Noelting and Collin, *Ber.*, **17**, 265, 268 (1884).

[4] Andersag, *Chem. Zentr.*, 1, 3595 (1934).

[5] Landsberger, *Ber.*, **31**, 2880 (1898).

[6] Ehrlich and Pistschimuka, *Ber.*, **45**, 2431 (1912).

Production of Quinolyl and Pyridyl Anions during Decarboxylation

IT has been shown[1,2] that when picolinic and quinaldinic acids are decarboxylated in the presence of aldehydes and ketones, α-pyridyl and α-quinolyl carbinols of the type Py(Qy).CH(OH).*R* are produced in good yields (40–80 per cent). The course of this reaction has been formulated in terms of the intermediate formation of α-pyridyl and α-quinolyl anions, which are formally of cyanide ion type[1,2]. The possibility that the cyanide function might by conjugation be extended to the γ-position has been confirmed recently by Mislow[3], who has obtained γ-pyridyl diphenylcarbinol by the decarboxylation of *iso*nicotinic acid in benzophenone. We now report that we have prepared γ-quinolyl diphenylcarbinol, m.p. 247°, from cinchoninic acid and benzophenone in yields of 7–10 per cent; we are developing the reaction as a possible route to quinine analogues.

We also find that, in the presence of decarboxylating quinaldinic and picolinic acids, it is possible to exchange the alkoxy groups of esters for pyridyl and quinolyl groups and to effect substitution by these groups at cationoid (electrophilic) centres in aromatic molecules; we take this to confirm our view that quinolyl and pyridyl anions are produced during the decarboxylation process.

B. R. BROWN
D. LL. HAMMICK
B. H. THEWLIS

Dyson Perrins Laboratory,
University, Oxford. April 15.

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[1] Dyson and Hammick, *J. Chem. Soc.*, 1724 (1937).

[2] Ashworth, Daffern and Hammick, *J. Chem. Soc.*, 809 (1939).

[3] *J. Amer. Chem. Soc.*, **69**, 2559 (1947).

Ecology of Sponges

THE statement has often been made that sponges can be found growing almost up to high-tide mark. As a result of close observation over miles of shore in a dozen different localities on the south and west coasts of Britain during the past twelve months, I have no hesitation in saying that only exceptionally are sponges found above mid-tide level. Even then, the most to be seen are a few undersized specimens of *Hymeniacidon perlevis* (= *H. sanguinea* Auctt.) in damp sheltered crevices protected from swirl and direct sunlight; and these are no more than a foot above mid-tide.

The second current statement proved to be false is that sponges are capable of surviving considerable desiccation. Careful observation shows that rarely are they found growing where there is no drip, or where they are not overhung with seaweed. I have found a few specimens of *H. perlevis* exposed to the strong rays of a spring sun. After exposure of two hours or more, between the ebb and flow of the tide, they have appeared dry and the surface shrivelled. The following day they have appeared completely regenerated. By marking such specimens and inspecting them at intervals, the following sequel has been established. They can appear regenerated after several such exposures; but in due course they disintegrate by stages, and after a month, instead of a sponge 50 mm. square, there are found a few small growths each about 5 mm. across. In two to three months time, depending on the amount of sunshine, even these feeble residues are gone.

The third, oft-repeated, fallacy is that sponges have no enemies apart from the nudibranchs that feed on them. I have often found *Patella, Littorina littorea* and *L. obtusata* on sponges, and have found their stomachs to contain spicules. At least two other gastropods are suspect. *L. obtusata* feeds more particularly on *Grantia compressa* and can often be found on it with its mouth closely fixed on the rim of a large hole in the wall of the sponge. There is sufficient circumstantial evidence for the view that these holes, commonly found in the sides of *Grantia*, are entirely the work of *Littorina obtusata*.

The fourth fallacy is that *Halichondria panicea* is the sponge most commonly found on the shore. *Hymeniacidon perlevis* grows higher up the beach and is more abundant; but because it is usually tan, or a dull brick-red, as against the conspicuous green or yellow of *Halichondria*, it is less readily seen. In some places it is a hundred times more plentiful, bulk for bulk, often twenty times, and, at a rough but conservative estimate for all British coasts, not less than ten times as plentiful. This last low average allows for any occasional restricted areas there may be where *Halichondria* is as abundant, or slightly more abundant, than *Hymeniacidon*, and of which I have not had experience.

Finally, there is clear evidence of a zoning of sponges. From mid-tide level there is usually (in my experience, always) a zone of *Hymeniacidon perlevis*. This gives place, at a depth varying with local circumstances, to a mixed *Hymeniacidon perlevis–Halichondria panicea* zone, extending approximately to the shallowest low-water neaps. In this zone, but of sporadic occurrence, may be found *Sycon ciliatum, Leucosolenia coriacea* and *L. complicata*. The next zone contains predominantly *Grantia compressa*, with scattered *Hymeniacidon, Halichondria, Sycon*, and the two species of *Leucosolenia*, rarely anything else. The *Grantia* zone is bounded roughly by the shallowest and deepest low-water neaps. In the last zone, of the low-water springs, we find the richest crop. Here thirty or more species may occur, including those already mentioned for the first three zones.

This zoning, although like all zoning it is not absolutely invariable, is sufficiently consistent to serve as a working guide. To the experienced eye it is a good enough (the word infallible might almost be used) index to the state of the tide.

The fallacious ideas referred to above may individually seem unimportant; but in any study of the ecology of sponges they can, if not corrected, lead badly astray.

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Neurotic Behaviour in Ants

WHILE investigating ant learning with maze apparatus, behaviour was observed in one individual which is similar to that described by Cook[1] and Maier[2] as psychopathic or 'neurotic' behaviour in rats. What are thought to have been early symptoms of similar behaviour were later observed in a virgin female of the same colony of *Formica fusca* Latr.

The particular worker ant concerned was one of several which had already several times successfully completed this maze. On completion of the run, the ants were normally picked up in the experimenter's fingers (an act to which they were habituated and against which they did not struggle) and returned to the observation nest in which they were kept; that is, in effect, to their fellow-workers and a female which was at that time laying eggs.

On this occasion the worker ant had already successfully run the maze almost immediately after being placed in the starting chamber, making few errors and quickly correcting those which it did make. It was then placed back in the nest; but about five minutes later was once more taken from the nest and replaced in the starting chamber. It at once exhibited slight jerking movements of the legs and antennæ, but soon commenced to run the maze, moving very quickly and without error or returning, until halfway through, when it missed one of the solution-turns and followed an error-path until it reached its blank end. At first it made no movement back along the error-path, but with rising physical excitement and an increasing jerking of the limbs and antennæ constantly touched the three glass sides of the maze in the immediate vicinity of the blank end. After about a minute it returned along the error-path until near its commencement, where for a few seconds it remained standing while exhibiting constant and increasing limb and antennæ jerking. It then turned until facing down the error-path, and still jerking moved with a staggering motion backwards (the limb-jerking, which appeared to be completely out of its control, made ordinary movement a matter of difficulty) and almost at once commenced to circle, still backing, in a small area of the intersection of the tracks. The rapidity of the circling increased and the jerking became even more pronounced, and a few seconds later the ant was rescued, since it was, for other reasons, of experimental value. It was quiescent while held firmly in the experimenter's fingers, but was placed under a tap of cold running water for about ten seconds before being returned to the nest. In the nest it still exhibited slight tremors of the legs and antennæ, but soon ran about normally. On the next day the ant ran the maze successfully with some errors, but no sign of its earlier behaviour. On one following occasion, however, it showed pronounced jerking movements of limbs and antennæ after making the same error, and commenced trying to clean itself. It was, however, at once rescued and returned to the nest. This particular individual is one of the most active workers of that particular colony, and also proved to be among the three workers of the colony (which consisted of 23 workers and two females) which were most successful at maze-learning.

A virgin female which was originally taken from the same colony but which had been isolated for nearly two months exhibited similar marked jerking movements of antennæ and legs on being placed in a strange plaster nest (she had previously been in a glass one containing earth). These movements soon stopped, however, when another virgin female was placed in the nest with her about one minute later.

I know of no previous records or accounts of similar behaviour in ants.

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[1] Cook, S. W., *Psychosom. Med.*, **1**, 293 (1939).

[2] Maier, N. R. F., "Studies of Abnormal Behaviour in the Rat" (New York: Harpers, 1939).

Distribution of Lugworms

On the muddy sand of the Whitstable flats the casts made by the large population of *Arenicola marina* L. do not appear to be distributed in random manner at all times of the year. During the summer months there are straight lines, a foot or two wide, along which the casts, and very probably the worms, are more numerous than they are on the adjacent parts of the shore. There is no mistaking these lines, which appear clearly in photographs of the shore. They may be a hundred yards long and are apparently arranged in all directions, being neither all parallel with, nor all at right angles to, high or low tide marks.

We have been unable satisfactorily to account for this grouping; but a few preliminary tests suggest that the layer of soil worked by the worms and which overlies the clay substratum is deeper along the lines than on either side of them. We have not yet been able to discover what is the cause of the difference in soil depth.

We should be very interested to hear if this grouping phenomenon has been noticed on other *Arenicola* shores and we should be grateful if anyone who has observed it would write to us, especially if he has any explanation to offer.

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June 2.

Life-History of *Splachnidium rugosum*

The peculiar brown alga, *Splachnidium rugosum*, has been a subject for investigation on a number of occasions. Early workers considered that it should be classed with either the Laminariales or the Fucales. In 1920, Skottsberg[1] pointed out that the resemblances to those orders were more apparent than real and that its proper position should be near to the Chordariaceæ. Skottsberg went on to suggest that there should be a sexual generation, as he considered the commonly known plant to be asexual, reproducing by zoospores from sporangia borne in the conceptacles.

I have spent some time investigating the life-history of this alga, and I can now confirm Skottsberg's suggestions. The sporangia, which are unilocular, give rise to numerous swarmers which do not fuse and must therefore be zoospores. These swarmers settle down and germinate to give a dwarf, microscopic, branched, filamentous thallus so characteristic of many members of the Ectocarpales and allied orders. This thallus, which is presumably the gametophyte, has been maintained in culture now for more than a year: so far, however, no gametangia have been produced.

The account will be published later in full elsewhere. I wish to express thanks to Prof. V. J. Chapman for his advice during the course of this investigation.

R. J. Hopkins
Botany Department, University College,
Auckland, New Zealand.
April 20.

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[1] Skottsberg, C., *Svensk. Bot. Tid.* (1920).

A Method of Distinguishing between Young and Old Colorado Beetles

Previous records do not appear to give any indication of how to distinguish between young and old Colorado beetles, except during the first few days following the emergence of the young beetle. I have found evidence that it is possible to separate young and old beetles for a period of at least fourteen days after the emergence of the young adult by means of colour changes in the membranous wings. This fact is of considerable practical importance and assistance to entomologists, especially in countries where the beetle has not yet become an endemic pest.

Trouvelot states (private communication, 1946) that it is only possible to distinguish between young and old beetles for several days after emergence, (1) by the fact that the chitinous integuments remain soft for the first two to three days, after which they become hard like those of the mature beetle, and (2) by the fact that the yellow colour of the elytra takes several days to reach that bright hue so characteristic of the mature adult.

In looking for a more satisfactory method whereby young and old beetles could be separated for a longer period of time, I found the colour difference between the membranous wings of the freshly emerged and mature beetles was very marked, and appeared to remain distinguishable, although to a decreasing extent, for approximately fourteen days.

The membranous wings of the fresh emergent are transparent and devoid of colour, while those of the mature beetle are red except for the apex and anal border of the wing. The wings remain colourless for at least four to five days after emergence, and afterwards develop a pink colour which gradually deepens and diffuses over the greater part of the wing surface, especially along either side of the nervures, until the pink colour has given place to a distinct red hue. On an average it takes fourteen to twenty days for the colour intensity to equal that of the mature beetle. This colour change is probably due to the carotene absorbed by the beetle when it commences to feed. Therefore the period taken for the wing to reach the maximum colour intensity will vary within certain limits, according to the temperature and intensity of feeding.

It is hoped to publish fuller details of these findings at some future date.

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GOLGI APPARATUS OF LIVING HUMAN TESTICULAR CELLS SEEN WITH PHASE-CONTRAST MICROSCOPY

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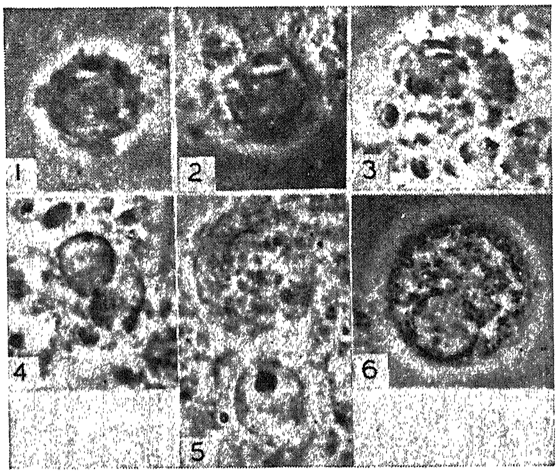
IT was pointed out previously that in the unstained living human spermatid the Golgi apparatus is sometimes discernible with bright-ground illumination, as an area slightly differing in refractive index from the remainder of the cytoplasm[1]. Recently, I have been able to confirm and extend these observations with the phase-contrast microscope. This instrument was of the phase-accelerating or positive type, so that dark and light regions in the image indicated higher and lower refractive indices, as a rule.



FIGS. 1–6 ARE UNRETOUCHED PHOTOMICROGRAMS OF LIVING HUMAN TESTICULAR CELLS TAKEN WITH A COOKE PHASE-CONTRAST SYSTEM, OBJECTIVE N.A. 1·30, MAGNIFICATION × 1,000, KODAK CONTRAST PROCESS ORTHO FILM. TRACINGS OF THESE FIGURES ARE GIVEN ON THE RIGHT AND INDICATE IN ADDITION STRUCTURES REVEALED BY CHANGE OF FOCUS

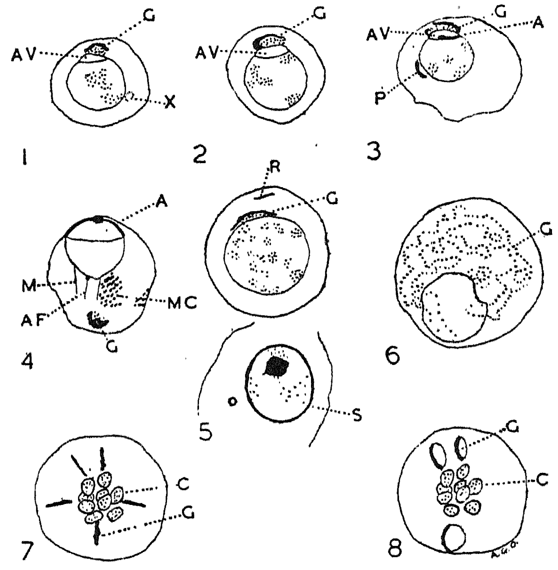
Figs. 1–4. Spermatids. Fig. 5. Primary spermatocyte and Sertoli cell. Fig. 6. Interstitial cell

Fresh testicular tissue was obtained from a European aged twenty-nine, at operation, and three Bantu, two aged twenty-eight and one aged twenty-three, less than half an hour after sudden and violent death. The biopsy specimen was preserved in plasma and also in Ringer–Locke solution, and the post-mortem material in pericardial fluid. Examination of the teased cells began within two or three hours after removal and extended over a period of ten hours.

In the earliest spermatids (Figs. 1 and 2), with phase-contrast microscopy, the acrosomal vacuole appears as a clear hemispherical space, slightly indenting the nuclear membrane. External to this lies a smaller dark hemisphere composed of a darker cortex and a lighter medulla. In some spermatids this cortex forms a continuous rind; in others it is interrupted and seems to consist of separate segments (Fig. 3). In older spermatids, the acrosomal granule and acrosomal cap can be seen within the acrosomal vacuole (Fig. 3). This vacuole gradually diminishes in size and, simultaneously, the dark bilaminar hemisphere comes to lie on its margin. In still later stages (Fig. 4), the acrosomal vacuole can no longer be seen, and the dark body, still composed of cortex and medulla, can be found lying free in the cytoplasm caudal to the nucleus, outside the area enclosed by the manchette.

Near the posterior region of the nucleus of the early spermatids, another dark cytoplasmic body is often evident (Fig. 3). This is probably identical with the postnuclear body. It has roughly the same size as the bilaminar structure already described, but it may be differentiated from it by its situation and the absence of two distinct zones.

It is relatively certain that the dark bilaminar body described in the spermatid is identical with the structure usually regarded as the Golgi apparatus in fixed tissue impregnated with silver or osmium tetroxide[2]. The body seen in living spermatids resembles the Golgi apparatus of impregnated spermatids in size, situation and behaviour, and such morphological differences as may be observed can quite easily be explained by known effects of impregnation[3].



FIGS. 7 AND 8 ARE DRAWINGS OF A SINGLE DIVIDING PRIMARY SPERMATOCYTE. FIG. 8 WAS DRAWN FOUR HOURS AFTER FIG. 7. *A*, acrosome and acrosomal granule; *AF*, axial filament; *AV*, acrosomal vacuole; *C*, chromosomes; *G*, structures presumed to be identical with the Golgi apparatus; *M*, manchette; *MC*, mitochondria; *P*, presumed to be the post-nuclear body; *R*, rodlet; *S*, Sertoli cell; *X*, artefact, an extra-focal image of an extracellular granule

In testicular cells other than spermatids definition of the Golgi apparatus is difficult, since in these cell types it presents fewer distinctive characteristics. A Golgi element was not recognized in the few secondary spermatocytes examined, nor in cells undergoing second meiotic division. Near the nuclear membrane in primary spermatocytes (Fig. 5) a dark crescentic structure was observed, in which a dark cortex and thin inner medulla could sometimes be distinguished. In addition, a single straight rodlet was often visible in the cytoplasm. This rodlet may be an isolated dictyosome. In several cells undergoing the first meiotic division a number of similar rodlets were observed, lying outside the spindle area, quite distinct from the chromosomes. In one cell in Ringer–Locke solution these rodlets were first observed at the sixth hour after removal (Fig. 7). Four hours later the cell was found to contain several lenticular vacuoles, each bearing a distinctly curved rodlet on one side (Fig. 8), very like dictyosomes. It is not certain that these are Golgi bodies, but they were quite unlike astral rays or mitochondria.

In the unstained spermatogonium the Golgi apparatus could not be satisfactorily distinguished from mitochondria, though occasionally a crescentic body like that of the primary spermatocyte was present. The Golgi element was not observed in living Sertoli cells.

In interstitial cells there was no evidence of a dark Golgi element; but a 'canalicular' network ramified through the cytoplasm (Fig. 6). This network is larger than the Golgi apparatus of impregnated interstitial cells, but has a remarkable similarity to the 'negative Golgi' which sometimes is produced in silver impregnations.

We may conclude, therefore, that with phase-contrast microscopy, in living testicular cells, structures are revealed which resemble the Golgi apparatus of impregnated cells. It would seem that no constant structure can be assigned to the Golgi element: it may appear as straight or curved rodlets, bilaminar crescents, or as a reticulum, depending on cell type.

Finally, it must be remembered that, invaluable as the phase-contrast method is in the study of living cells, interpretation of appearances will require experience and understanding, since spurious images are common (Fig. 1).

I am indebted to Dr. Jonathan Gluckman for the loan of the Cooke phase-contrast microscope used in these studies.

[1] Oettlé, A. G., *S. Afr. J. Sci.*, **37**, 239 (1940).
[2] Gatenby, J. B., and Beams, H. W., *Quart. J. Mic. Sci.*, **78**, 1 (1936).
[3] Baker, J. R., *Quart. J. Mic. Sci.*, **85**, 1 (1944).

PERMEABILITY OF THE MEMBRANES OF THE HEN'S EGG

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PERMEABILITY to electrolytes. Under normal conditions the membranes of plant cells are impermeable to electrolytes. But under abnormal conditions (transfer to solutions of pure electrolytes) the electrolytes can pass through (deplasmolysis). In this connexion, if one compares solutions of different electrolytes, one can observe that they follow the Hofmeister series. The series in which the hypotonic solution of electrolytes can cause hæmolysis of the red corpuscles is the same as the Hofmeister series. We have examined these conditions, using hen's egg membranes. According to the experiments of A. Orru[1], the permeability of the vitelline membrane to water was influenced by hydrogen and hydroxyl ions and by the presence of different electrolytes, and that complex ions can pass through as well.

We have examined fresh hen's eggs only a few hours old. In order to establish the permeability of the vitelline membrane to different neutral potassium salts, iso-osmotic solutions were prepared from potassium oxalate, phosphate, sulphate, chloride, bromide, iodide and thiocyanate at — 1·45° C. of an approximate strength of 0·4/mol. The yolk of the egg, contained within an unbroken membrane, was placed in a flask and washed thoroughly with distilled water. 115 ml. were used to form the iso-osmotic solution for each experiment.

At the beginning of each experiment 15 ml. of the solution were extracted from the bottle for the examination of the content in anions of the salt. The bottle was kept throughout in a refrigerator at + 6° C. 5 ml. were taken from the bottle at forty-eight hours and after four days to determine if any fixation of anions had taken place through the yolk. By subtracting the values, which were found after forty-eight hours and four days, from the values of anion obtained at the beginning of the experiment, we could calculate the quantity fixed through the yolk. Also we found that albumin emerges from the yolk when this is in an electrolyte solution. This quantity of albumin was determined in the outer solution. To each 5 ml. of samples that were taken out of the flask, 1 ml. of 20 per cent trichloracetic acid was added. The filtered albumin precipitate was washed until the filtrate showed no detectable traces of the anion under test. The albumin precipitate was then dried at 105° C. and weighed. The determination of chloride, bromide, iodide and thiocyanate in the filtrate was carried out by precipitation methods. The sulphate was determined by the benzidine method, the oxalate through the oxidation method. For examination of permeability outwards the yolk was placed in 100 ml. of distilled water. The flask was also kept at a temperature of +6° C. The chemical examination of the outer liquid after one, two and twenty-four hours has proved that the albumin reaction with sulphosalicylic acid and the reaction for chloride with silver nitrate was positive and had become far more positive twenty-four hours afterwards. For examination of the permeability of the cuticle we filled the shell with 20 ml. of a cold saturated solution of potassium ferrocyanide and we placed this shell in a cold saturated ferri-ammonium sulphate solution.

The volume of the yolk was increased in the iodide, thiocyanate and oxalate solution. Sometimes a bubble developed full of the liquid in the upper pole of the yolk and the yellow substance was repelled. The outside solution became either yellow or remained clear. The vitelline membrane after remaining for eight days in the potassium iodide solution became harder and split with difficulty. The internal substance became much more viscous. The fixation of anions in the yolk followed the Hofmeister series. The iodides were more fixed than their place in the Hofmeister series would allow. The oxalates were also more fixed, perhaps by damage of the membrane caused by calcium precipitation (see accompanying table). The diffusion of potassium ferrocyanide through the cuticle placed in a ferri-ammonium sulphate solution led to the formation of Prussian blue spots corresponding to the outer exits of the air tubes of the cuticle.

Anion	Anion fixed gm. % ml.		Albumin gm. % ml.
	48 hours	after 4 days	4 days
Oxal.	0·35	0·42	3·0
SO_4	0·04	0·12	0·49
PO_4		0·11	1·34
Cl	0	0·06	0·19
B_2	0·08	0·13	0·14
I	0·25	0·22	0·33
SCN	0·07	0·11	0·99

Permeability to electrolytes in the presence of narcotics. In these experiments, which were made chiefly with potassium iodide, the same materials and methods were used as in the above, the only difference being that the outer solution instead of being pure salt solution was saturated with a narcotic. If we compare the above results with the pure potassium iodide solution and those with the same solution saturated with a narcotic, under the above-mentioned experimental conditions, we do not find significant differences in the fixation of iodine through the vitelline membrane. The differences found are within the range of the individual variations in the permeability of the vitelline membrane of different eggs. In the case of the albumin, in some of the above experiments but not in all, more of it was found in the outer solution than in an experiment with a pure water solution of the salt.

Thanks are due to Prof. Joachimoglu for advice during these investigations.

[1] Orru, A., Biol. *Abstr.*, 14, 2, 211 (1940); *Chem. Zentralbl.*, 1, 534 (1941); 2, 1462 (1940).

EXCAVATIONS OF A ROMAN HOUSE

DR. FELIX OSWALD has now carried further the story of his years of excavation at Margidunum*. So little remained of the buildings of the first-century camp after the Roman demolitions in Hadrian's reign that at first the excavator seemed faced with a hopeless task; but by the painstaking investigation of every foot of the area concerned, down to the level of the undisturbed subsoil, the greater part of the plan of a building identified as the Commandant's House was revealed. Unfortunately, the eastern rooms of this house lie beneath the Fosse Way, which crosses the centre of the camp at this point, and possibly a hypocaust may lie buried here, as none was found elsewhere.

The usual sequence of two buildings, one of timber and one of stone, was found, the first dating from the time of the foundation of the camp by Ostorius Scapula in A.D. 48, and destroyed during the Boudiccan rebellion, and the second erected, after the lapse of a few years, during the reign of Vespasian or Titus, and remaining in use until the end of the occupation of the camp. The surviving post-holes were too few for the plan of the timber building to be recovered, but the plan of the later house is of a type allied to that of houses known from other forts, and several of the plans of these are illustrated, drawn to the same scale for purposes of comparison. Stables may have existed to the north of the house, and an interesting feature is a pit contemporary with the timber building, which in view of a parallel at Hofheim, the excavator thinks may have been used for preserving oysters in salt water.

The major part of the report is devoted to the description, discussion and illustration of the pottery found on the site. The Terra Sigillata showed no very unusual features; but among the coarse wares of the earliest phase (Claudius–Nero), a large store-jar with an impressed stamp of three stars above two rosettes on its lower half was an unusual discovery, and it is suggested that this may indicate a measure of quantity. The coarse ware of the succeeding phases shows considerable development, and includes frequent imitations of Terra Sigillata forms. Evidence was also found showing that some of the pottery of Vespasianic date was made at the Castor potteries. Any discoveries which help to tie down the dating of the products of these potteries are of particular interest owing to their increasingly widespread distribution. Altogether this report makes important additions to the mass of valuable comparative material with which Dr. Oswald has already provided us.

* The Commandant's House at Margidunum. By Dr. Felix Oswald. Pp. 41 (17 plates). (University College, Nottingham, 1948.) 7*s.* 6*d.*

SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES

ANNUAL CONGRESS, 1948

AT the invitation of the Mayor and the Corporation of Great Yarmouth, and with the co-operation of the Great Yarmouth Naturalists' Society, the South-Eastern Union of Scientific Societies held its fifty-third annual congress during June 14–19 at Great Yarmouth, under the presidency of Mrs. Jacquetta Hawkes. The Mayor, in his welcome to the Congress at the Town Hall, where accommodation was provided for meetings by the Corporation, said that those who were not versed in 'old buildings' could not appreciate the beauty of them, and that societies such as he was addressing opened the eyes to the reasons why such old buildings as those on the South Quay at Yarmouth should be preserved. Capt. Dannreuther inducted the president, and congratulated her upon being the first lady to hold the office since the foundation of the Union more than fifty years ago.

Mrs. Hawkes, in delivering her address upon "Archæology and the Present", said that two world wars had disturbed the faith in the certainty of progress in a way resembling the questioning of the story of Genesis by the theory of evolution. She believed that archæology provides a sense of comfort by comparisons, such as life in a palæolithic cave with life at Versailles or the compositions of Beethoven. The popularity of the subject is perhaps due to the solace obtained from the study of the solidity of the past compared with the flimsiness of the present and the uncertainty of the future. An education based on classical studies has been a great force in Britain, and it is of utmost importance to salve what is valuable and to adapt it to the changing conditions. Archæology can play its part by saving classical studies from exclusiveness and isolation. It can add intimacy and humanity to the classics to make the acceptable to a greater number.

Mrs. Hawkes said she believes that if the archæological method, in the widest sense of the study o material things through all the periods, can becom an accepted part of teaching, the distaste of peopl of all classes for vulgar architecture and badly designed utensils would lead to an improvement of our environment and thus to the general betterment of all. Archæology could display a vast array of cultures which would help us to decide how to search for new values and to teach us that mechanical gadgets are not essential to the fulfilment of valuable lives.

The Archæological Section of the Union was addressed by its president, Lieut.-Colonel S. E. Glendenning, on "Local Materials and Craftsmanship in Norfolk Buildings", and a paper on "Roman Britain as seen in the Yarmouth Neighbourhood" was read by Mr. P. E. Rumbelow, who also conducted an excursion to the Roman Station at Burgh Castle.

Mr. H. J. Howard delivered the presidential address to the Botanical Section on "The Mycetozoa of Sand-dunes and Marshland", and Mr. F. O. Whitaker's paper on "The Botany of the Cromer Forest Bed" was read. Joint excursions, with the Zoological Section, were conducted to Fritton Lake, Wheatfen Broad and Norwich.

The Geological Section elected Mr. C. D. Ovey as president, and his address was upon "Foraminifera in Stratigraphy with special reference to the Ecology of Living Forms". A paper was read on "The Geological and Archæological Problems of the Red Crag" by Mr. S. Hazzledine Warren, and Mr. J. E. Sainty gave a paper upon "The Geology of Norfolk". He also arranged and conducted successful excursions to the Norwich and Cromer areas in illustration of his views upon the formation of the district.

The Zoological Section's presidential address was given by Major Maxwell Knight on "The Study of Bird Pellets as a Subject of Interest and Instruction to Amateur Naturalists". A paper was read by Dr. Malcolm Smith on "Some Undetermined Points in the Life-Histories of the British Reptiles".

An evening conversazione was arranged by the Great Yarmouth, Lowestoft and Norwich Naturalists' Societies. A very successful Young Naturalists' evening was held at the Town Hall. Coloured Nature films, specially taken at the London Zoo by Mr. Douglas Fisher, were exhibited. The commentary on the first two, dealing with snakes, lizards, newts, frogs and toads, was given by Dr. Malcolm Smith, and that on the third, concerning the behaviour of the tarsier, was given by Major Maxwell Knight. The remainder of the evening was devoted to a naturalists' brains trust, the arrangements for which were in the capable hands of Major Maxwell Knight, who also acted as question master. His 'brains' were: Capt. T. Dannreuther, Mr. E. A. Ellis, Mr. David Seth-Smith and Dr. Malcolm Smith. Questions were selected from those sent in by schools in the area, a request having been made that they should be debatable rather than factual. Although admission was limited by the issue of tickets, more than a hundred additional young people got into the hall, which, besides giving encouragement to the organisers, should also give hope to those whose theme is the rejuvenation of the local natural history societies. The question master suggested to the delegates present that each of the seventy societies affiliated to the Union might, with advantage, arrange similar meetings.

After the general assembly, the discussion on "The Functions and Organisation of Local Societies", in continuation of that initiated by the British Association, was opened by Mr. G. Gosnell.

The next congress of the Union will be held at Canterbury during Easter 1949.

SMITHSONIAN INSTITUTION

ANNUAL REPORT

THE report of the Secretary of the Smithsonian Institution, Washington, D.C., for the year ended June 30, 1947, which includes reports on the newly established National Air Museum and on the Canal Zone Biological Area, recently placed under the administration of the Institution, records the resumption and, in some directions, expansion of much of the normal research and field-work suspended during the War. Accessions to the National Museum are back to pre-war levels, and the International Exchange Service has considerably reduced the accumulation of material for foreign exchange built up during the war years, and the service will soon be again on a current basis. The two greatest needs of the Institution are additional staff and more building space.

Under the Canal Zone Biological Area Advisory Board, a wide range of studies and tests has been carried out under tropical conditions. Those in progress include an extensive organisation for testing the proofing of wood to termites, the tropical deterioration of plywoods, textiles, and packaging containers, and the effect of fungi on optical glass. Some four hundred publications have been issued on research carried on there in entomology, forestry and medicine with special reference to the control of termites, fruit flies and mosquitoes.

Appended to the secretary's report is the Financial Report of the Executive Committee of the Board of Regents, as well as separate reports on the National Museum, the National Gallery of Art, the National Collection of Fine Arts, the Freer Gallery of Art, the Bureau of American Ethnology, the International Exchange Service, the National Zoological Park, the Astrophysical Laboratory, the National Air Museum, the Canal Zone Advisory Board, the library and publications.

The report from the National Museum refers to the resumption of investigations of fifteenth-century historic Indian village sites and some of the early Spanish settlements in the West Indies, to the continuation of the survey of the fishery resources of Guatemala, a botanical survey of St. Vincent, and to field work on the lower cryptogams as part of a biological survey of the Patuxent Research Refuge. Systematic researches under the Bureau of American Ethnology recorded during the year include the River Basin Surveys, aimed at recovering such archæological and palæontological information and materials as will be lost through the construction of dams and creation of large reservoirs in many of the river valleys of the United States. Papers prepared for publication deal with the State names of Mexico, the province names of Canada, and the detailed ethnographical description of the projecting rocks and islands off the coast of California, while a bibliographic project has been initiated having as objective the compilation of an annotated, fully indexed bibliography covering the descriptive, geographical and other scientific literature on the Arctic from the earliest historical writings to those of the present time. A roster of Arctic specialists is also being compiled which will afford a comprehensive record of the experience and specialized knowledge of scientific men, explorers, writers, and Arctic residents who possess first-hand information of value concerning the Arctic and sub-Arctic regions. A joint expedition with the National Geographic Society made an archæological survey of the Pacific coast of the State of Chiapas, Mexico, and the Viru Valley Expedition attempted to survey thoroughly a single valley of the Peruvian coast as a living unit through some three thousand years, including archæological, geographical and modern community studies.

The report on the National Zoological Park, in addition to listing accessions during the year, gives a complete list of animals in the Park at June 30,

1947. At the Astrophysical Laboratory, the Division of Astrophysical Research has been concerned mainly with appraising the solar-constant values received from its field stations and planning and developing improvements in instruments and methods. Eighteen months of continuous measurement of sun and sky radiation have been completed at Camp Lee, Virginia, and the work is being extended to include measurements and exposures at a wet, sea-level and a dry, high-altitude station. The Division of Radiation and Organisms was concerned with the role of light, especially the wave-length effects on the fixation of carbon by green plants, and with the mechanism of dormancy in seeds sensitive to light and the study of the developmental physiology of grass seedlings. A critical review of the literature dealing with the germination of lettuce seed is in preparation, and studies are in progress on the identification of volatile substances responsible for inhibiting the germination of several species of seeds.

The report on publications lists the titles of twenty-six papers in the Smithsonian Miscellaneous Collection, twenty-two in the general appendix to the Smithsonian Annual Report, and three bulletins from the National Museum.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Monday, July 12—Saturday, July 17

Society of Chemical Industry (at the Assembly Rooms, George Street, Edinburgh).—Annual General Meeting.

Wednesday, July 14

At 9.45 a.m.—Sir John Anderson, F.R.S.: "Science in relation to the Public Services".

Thursday, July 15

At 9.45 a.m.—Sir Robert Robinson, F.R.S.: "The Device of Imitation of Molecules in the Biological Field" (Lister Memorial Lecture).

Wednesday, July 14

Association of Optical Practitioners (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 2 p.m.—Dr. Matthew Luckiesh: "Factors Concerned in Vision, Light and Seeing".*

Wednesday, July 14—Friday, July 16

Physical Society, Acoustics Group (joint meeting with the Royal Institute of British Architects, at 66 Portland Place, London, W.1), at 10 a.m. and 2.30 p.m. each day—International Conference on "Noise and Sound Transmission".

Wednesday, July 14

At 10 a.m. and 2.15 p.m.—"Sound Transmission".

Thursday, July 15

At 10 a.m.—Papers of Architectural Interest.

Friday, July 16

At 10 a.m.—"Measurement of Noise and Vibration"; at 2.30 p.m.—"Applied Acoustics".

Saturday, July 17

Nutrition Society (in the Barnes Hall, Royal Society of Medicine, 1 Wimpole Street, London, W.1), at 10.30 a.m.—Conference on "The Nutrition of Athletes".

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lecturer in Physiology (Grade I or II)—The Secretary and Registrar, The University, Bristol (July 17).

Assistant Lecturer (Grade III) in the Department of Physics—The Registrar, The University, Liverpool (July 17).

University Lecturer in Botany, to lecture on Mycology or Mycological Plant Pathology—The Secretary, Faculty of Biology "A", Department of Zoology, Downing Street, Cambridge (July 17).

Lecturer in Pharmacology—The Registrar, The University, Leeds 2 (July 17).

Chemist or Physicist for testing of refractories, a Physicist for physical work connected with gasworks practice, a Chemist or Physicist for abstracting, collating and reporting from technical literature, and a Chemist to join research staff dealing with problems connected with gas manufacture—The General Manager and Secretary, City of Birmingham Gas Department, The Council House, Birmingham 3 (July 19).

Lecturer in Surveying for Department of Civil Engineering—The Secretary, University College, Gower Street, London, W.C.1 (July 23).

Senior Lecturer in Mathematics in the Department of Aerodynamics—The Registrar, The College of Aeronautics, Cranfield, Bletchley, Bucks, marked 'Senior Lecturer in Mathematics' (July 24).

Lecturer in Biochemistry for the Department of Physiology—The Secretary, Royal (Dick) Veterinary College, Summerhall, Edinburgh 9 (July 26).

Senior Lecturer or Lecturer in Botany for the University of Melbourne—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (July 31).

Professor of Botany at Rhodes University College, Grahamstown, South Africa—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (July 31).

Assistant Director of Research with practical experience of computation to work in the Mathematical Laboratory, and a University Demonstrator whose primary interest is statistics—The Secretary to the Appointments Committee, Trinity College, Cambridge (July 31).

Senior Lecturer or Lecturer in Anatomy (Histology)—The Registrar, The University, Sheffield (July 31).

Keeper of Antiquities—The Director, Museum and Art Gallery, New Walk, Leicester (August 30).

Chair of Applied Mathematics—The Registrar, University College, Southampton (September 20).

Agricultural Education Adviser—The Secretary for Education, County Buildings, Shrewsbury.

Assistant Lecturer and Demonstrator in the Physiology Department—The Secretary, King's College of Household and Social Science, Campden Hill Road, London, W.8.

Curator at the Municipal Museum—The Town Clerk, Town Ha Tunbridge Wells, Kent.

Laboratory Steward at the College, Swindon—The Boro Education Officer, Education Office, Civic Offices, Swindon, Wilts.

Lecturer in Biology—The Clerk to the Governors, South-E Essex Technical College and School of Art, Longbridge Road, Dage ham, Essex.

Lecturer in Biology in the Senior Technical College—The Pr cipal, Technical College, Luton, Beds.

Lecturer in Chemistry for Science Department, Munic Technical College—The Director of Education, Education St. Helens, Lancs.

Lecturer in Mathematics (male)—The Principal, Acton nical College, High Street, Acton, London, W.3.

Metallurgist to take part in investigations on casting o [illegible] and on ingot mould design and performance—The Personnel O British Iron and Steel Research Association, 11 Park Lane, Lor W.1.

Meteorological Forecasters for the East African a[illegible] African Meteorological Services—The Director of Recruitment (Col Service), 15 Victoria Street, London, S.W.1.

Physicist or Chemist to undertake research on adhesion [illegible] related properties of rubber, and a Physical Chemist to under research on latex—The Research Association of British Rubber M facturers, 105 Lansdowne Road, Croydon, Surrey.

Research Fellowships (2) in Education, within the [illegible] of Education—The Secretary, The University, Edmund [illegible] Birmingham 3.

Senior Assistant in the Engineering Department, Co Technical College, Wednesbury—The Director of Education (T F.E.), County Education Offices, Stafford.

Senior Lecturer in component and detail Stressing of [illegible] craft Structures in the Department of Aircraft Design—Registrar, The College of Aeronautics, Cranfield, Bletchley, B marked 'Senior Lecturer in Aircraft Stressing'.

Technician for the Department of Physiology and Phar cology—The Secretary, St. Mary's Hospital Medical School, Padd ton, London, W.2.

Timber Marketing Officer by Government of Nigeria, Comm and Industries Department—Crown Agents for the Coloni [illegible], 4 M bank, London, S.W.1, quoting M/N/17860/3E.

Lecturer in Chemistry and a Lecturer in Ph[illegible]sics—The P[illegible] cipal, County Technical College, St. James's Roa[illegible] Kingston-upon Thames, Surrey.

Lecturer in Civil Engineering—The Directo[illegible] ordon's Technical College, Aberdeen.

Lecturer in Mathematics and a Lecturer in [illegible] ty for Municipal Technical College—The Director of Educatio[illegible] ducation Offices, Library Street, Blackburn.

Lecturer in Mechanical Engineering—The Principal, [illegible] ds-worth Technical College, Golds Hill Road, Handsworth, Birmingham 21.

Lecturer in Mechanical Engineering—The Principal, Technical College, Queen Street South, Huddersfield.

Lecturer in Physics—The Principal, Birmingham Central Tec[illegible]-nical College, Suffolk Street, Birmingham 1.

Lecturer in Physics—The Clerk to the Governor[illegible] technic, London, S.W.3.

Senior Assistant Lecturer in the Department [illegible] Engineering—The Principal, Borough Polytechnic, [illegible] London, S.E.1.

REPORTS and other PUBLICATION

(not included in the monthly Books Supplement)

Other Countries

Government of Palestine: Board of Scientific and Indust[illegible] Research. Problems of Heat Physiology in Palestine. Report to t[illegible] Colonial Medical Research Committee by Dr. W. S. S. Ladell. [illegible] 22 100 mils; 2*s*. Survey of Literature o[illegible] e Influence of Ions on [illegible] and Soils. Compiled by Dr. A. Mil[illegible]. Pp. 46. 200 mils [illegible] (Jerusalem: Board for Scientific and [illegible] strial Research, 1948.)

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ABBREVIATIONS

IN one of those fanciful stories for children included in the "Just So Stories", Rudyard Kipling takes us in imagination back to Neolithic times and describes how an alphabet might have been devised. A stranger came upon a man and his small daughter, and the little girl thought she could send a message back to her mother by the stranger. Her message consisted of 'pictures' scratched on birch bark, but unhappily the pictures were completely misunderstood, with sad consequences for the stranger. As a result of this misadventure, the little girl started to draw signs to represent sounds, and in a short time with the help of her father produced an alphabet—it may seem curious that this alphabet should consist of the very letters used in modern English, but any other would clearly be pointless in a child's story written in English. Kipling must have realized when he wrote these two fascinating little stories, one showing the inadequacy of the picture language, and the other purporting to describe the origins of writing, the natural attraction of signs and symbols for children. The simplicity of the symbol in contrast with the complexity of a pictorial representation for conveying a message has always attracted children, and in these stories he gives the child struggling with the alphabet something tangible on which to base the written characters it is trying to recognize and reproduce.

The primary difficulties of spelling and writing simple words are normally overcome at an early age, and then comes a phase when they are used in play. 'Secret messages' become a feature of games, which very soon develop into the construction of simple codes, with all the delights of conveying information from one to another without their elders understanding. The obvious development in the world of adults is the preparation and use of more elaborate codes for various purposes. Mention must also be made here of the anagrams adopted by the alchemists and other natural philosophers for concealing their results from all but the initiated. With the growth of knowledge the use of anagrams died out; but what are we to make of the tendency in much modern scientific and other writing to sprinkle the page with symbols and abbreviations ? Has the pendulum swung back again ?

Going back to the child's delight in the use of 'secret messages', it is worth while recalling the pleasure with which many have learned the recognized symbols of the chemical elements, and delighted in their use with algebraic symbols to formulate chemical equations describing chemical reactions—alas, at first, many reactions which could never take place in man's chemical laboratories. But with this use of symbols came the warning of the careful teacher, that the symbols had a quantitative meaning, and while they might pass as abbreviations in private notes, they must not be used in writing up descriptive accounts of chemical work. With the progress of chemistry, and particularly of organic chemistry, it became extremely useful to denote certain definite groups of elements which pass from compound to compound apparently as units with special symbols; thus in addition to the symbols of the elements, we have 'Me' to represent the methyl group or radical, 'Ph' the phenyl group, and so on. Nevertheless, it was unusual to find such abbreviations in the text of chemical books and papers. Even more complicated substances are now being identified, particularly in the field of biochemistry, and with each new compound the urge to find and use abbreviations seems to grow. Adenosine triphosphate soon became 'ATP'; then there was 'ADP' (adenosine diphosphate); many others will come to mind. No one can blame workers in the rush of discovery jotting down abbreviations in their own notes, or even using them in writing down a reaction in symbols. But should they be used in the text of a paper? The symbols of the elements are internationally recognized, but many of these new groups of letters represent merely the initial letters of the English names of parts of a compound. Can it be accepted that such names will receive international approval, even if the constitution indicated be not disputed?

This use of symbols as abbreviations is, however, going further than the naming of compounds. Authors sometimes adopt their own abbreviation for a substance and seem to think that because they have defined it once at the beginning of a paper, they can then use it freely—and sometimes they do so without even the formality of a preliminary definition; we have seen in a communication submitted as a "Letter to the Editors" the symbol 'F', which on careful study was found to signify 'formaldehyde'. Another tendency is to use symbols as nouns, with the result that we find such phrases as 'an R_u of higher value'; the use of *p*H as a noun is perhaps sanctioned by long usage. It is apparently overlooked that very often a pronoun could adequately be used in place of the abbreviation. Attention to such matters might go some way towards meeting recent criticisms that scientific workers are unable to write intelligible English.

It must not be thought that chemists are the only offenders. Physicists have for many years used E.M.F., A.C., D.C., and more recently we have had 'h.f.' for 'high frequency' and 'r.f.' for 'radio frequency'; and there are symbols common to all the physical sciences such as N.T.P. and the various abbreviations, most of them well known and widely accepted, for weights and measures. But there does not seem to be the same urge to devise new abbreviations in this field.

The practice of using initial letters instead of the full names has come into increasing use in daily life during recent years. It is difficult to suggest where it started, though perhaps the Services must take a share in the blame; its placarding of camps with notice-boards having perhaps up to half a dozen letters indicating the whereabouts of officials whose functions were thereby indicated must have initiated many a recruit into the habit. Indeed, it became a point of honour to be able to talk to one's fellows in these 'letter' terms—whether this was a return to the secret-message game or due to the need for brevity need not be discussed. The names of institutions and bodies in civilian life have been similarly treated. We need only mention the Association of Special Libraries and Information Bureaux, widely known as 'ASLIB', or the Universities Federation for Animal Welfare, which is reduced to 'UFAW'. The ugly appearance of a succession of capital letters in a line of printed text is apparent, and possibly for this reason the tendency has been to use an initial capital letter only; the abbreviation then becomes a word, but not an elegant one in appearance or sound. The Department of Scientific and Industrial Research and the National Physical Laboratory are perhaps fortunate in that the initial letters do not form pronounceable words. The examples quoted are, of course, British, but equally curious names have been invented in other countries.

In the international field the same tendency has been apparent. The United Nations Organisation quickly became 'UNO' and then 'Uno'; the United Nations Relief and Rehabilitation Administration became 'UNRRA' and 'Unrra'. The United Nations Educational, Scientific and Cultural Organisation has become 'Unesco'. Now we have the World Health Organisation, which is heading its publications 'WHO'. The Students International Clinical Congress now in session in London, Oxford and Birmingham opens a descriptive programme with an article entitled "A welcome to SICC delegates"!

The examples, from many fields of activity, could easily be multiplied. What is the remedy? Or, perhaps, what can be done to check the appearance in various languages of artificial words, which usually happen to be ugly in appearance and uncouth in sound? Words which have already passed into general use will no doubt stand or fall by virtue of their suitability to express a particular function or object. In devising titles of new institutions or bodies, however, consideration should be given to the possibility that initial letters may be used in abbreviation, and suitable steps taken. It should not be beyond the wit of man to provide titles which are conveniently short or capable of reasonable abbreviation.

THE ART OF WRITING

The Alphabet

A Key to the History of Mankind. By Dr. David Diringer. Pp. 607. (London: Hutchinson's Scientific and Technical Publications, n.d.) 50*s*. net.

THIS exhaustive work incorporates the substance of the author's "L'alfabeto nella storia della civiltà" (Florence, 1937) and includes all non-alphabetic systems of writing, as well as the great family of true alphabets derived, so the author believes, from a single source in Phœnicia or North Syria. The two systems are curiously separate their history, and it is no accident that the t alphabet originated in one of the very few regions where, by a series of historical accidents, the Cuneiform, Hieroglyphic, and probably also the Minoan systems overlaid each other, and set people thinkin about a revolutionary change.

Each group of scripts is introduced by a shor account of their region and people of origin, and supplied with a select bibliography. Theories of origin or derivation are summarized, and usually Dr. Diringer has his own reasoned conclusions. On the priority of Egyptian or Sumerian pictorial writing, he reserves judgment. He shows (p. 61) how narrowly Egypt missed a truly alphabetic script, and by what steps, having done so, they supplemented their imperfectly syllabic script.

The account of the Cretan or 'Minoan' scripts is disappointing, for it has escaped recent revision, and does not mention Pugliese-Carretelli's admirable edition of the 'Linear A' tablets from Hagia Triada, or the discovery of 'Linear B' archives near Pylos on the Greek mainland. The tables of signs are imperfect and confused with commodity-signs, masons'-marks, ligatures, and other symbols. Dr. Diringer describes the unique Phaestos Disk as a 'stamp or ig die', whereas it is itself printed with movable type. He confuses 'Pictographic Class A' with Linear Class A' (Fig. 7*a*), and exaggerates the number of tablets found at Knossos (p. 76). He regards the Cretan system as essentially indigenous, though influenced by Egyptian hieroglyphic. Of the source of clay-tablet writing, with punctuation, in Crete, he says nothing. He is probably right in regarding the language as not Indo-European, but akin to languages of later Asia Minor, like many words in Greek; and he notes, without emphasis, the resemblances of Cretan to Phœnician signs. On Hrozny's Indo-European theories he reserves judgment. In the account of Cretan ethnology (p. 74) 'Hawkes' should be 'Hawes', as in the bibliography.

It is still too early to write confidently about the script of the Indus Valley civilization. Dr. Diringer inclines to the lower dates proposed by Frankfort and Piggott (middle third millennium); and rejects de Hevesy's comparison with the inscriptions of Easter Island (p. 198).

For Hittite script—a thorny subject—Dr. Diringer inclines to a deliberate imitation of Egyptian writing, but with Anatolian or Syrian pictographs, about the middle of the second millennium. He mentions, without favour (p. 96), resemblances with Cretan signs, noting the discordant dates.

The immense duration and complexity of Chinese writing are clearly set out, down to modern attempts to simplify or supersede it, and there is a concise survey of the scripts of Central America and Mexico, of Southern China, of West Africa, and Easter Island. Fully syllabic writings, at Byblus, in Bronze Age and Classical Cyprus, in Japan, and among tribes of West Africa and North America, are treated summarily, and lead to the Persian and Meroitic scripts which are described as quasi-alphabetic only, and are therefore discussed separately here.

The alphabetic systems, very numerous and widespread, offer fewer problems, except the central question, 'where did alphabetic writing originate?' After reviewing older theories, Dr. Diringer adopts unand's derivation from the 'pseudo-hieroglyphic' script of Byblus (pp. 158, 205), which is traced back the twelfth or thirteenth Egyptian dynasty (*c.* 2000– B.C.). If this is maintained, the current 'Sinaitic' ation falls into place as one of several attempts adapt Egyptian writing to local needs; and bably the Minoan script is another, modified, wever, profoundly by the adoption of clay-tablet hnique.

t is impossible here to examine in detail the tions between the derivative alphabets. The main sis that they all go back to the Syrian archetype seems to be well founded, in contrast with the multiple origins of hieroglyphic and syllabic writing.

Though not without weak points, this book will be the main work of reference in this field for some time to come.

J. L. MYRES

WAR-TIME RADIO RESEARCH AT HARVARD UNIVERSITY

Very High-Frequency Techniques

Compiled by the Staff of the Radio Research Laboratory, Harvard University. Vol. 1. Pp. xvii+554. Vol. 2. Pp. viii+555–1057. (New York and London: McGraw-Hill Book Co., Inc., 1947.) 2 vols., 84*s*.

In compiling the text of these two volumes, the staff of the Radio Research Laboratory of Harvard University has followed the practice established in some recent books by which the different sections are written by separate authors, each being a specialist in his own domain. In this case the individual contributions have been welded together into a fairly comprehensive treatment of the whole field under the editorship of Dr. H. J. Reich and a group of assistant editors. As mentioned by Dr. Reich in his preface, the book should not be regarded as a text-book but rather as a reference work or hand-book which will serve as a valuable source of information to research physicists and engineers working in this field, and to future authors of text-books.

The Radio Research Laboratory at Harvard was primarily responsible for developing counter-measures to enemy radar: thus, throughout the work, particular emphasis has been given to conditions permitting broad-band or tunable operation of the techniques described, in contrast to the fixed-frequency operation of radar. In this way a new and interesting point of view is brought to bear upon the problems involved in the generation, transmission and reception of very high-frequency electromagnetic waves.

Volume 1 contains twenty-two chapters, of which the first eight are chiefly given to a discussion of the various types of antennæ in use at frequencies greater than 100 Mc./sec., with the overriding requirement of broad-band frequency characteristics. The principles of direction finding are then introduced, followed by a description of antennæ and indicators suitable for radio direction finding and of the devices employed in the rather specialized form of the latter known as 'homing'. These twelve chapters may be regarded as a part of the book sensibly complete in itself, and the remaining sections of Vol. 1 are concerned in turn with the various types of very high-frequency oscillators for use in transmitters giving relatively medium- and high-power outputs. Attention is also given to the requirements for amplitude and frequency modulation, and in the last three chapters the principles and characteristics of the magnetron are enumerated and discussed.

The externally tuned magnetron oscillator is treated at the beginning of Volume 2; afterwards, the methods of ultra-high-frequency power measurement are reviewed and the general principles of receiver performance dealt with. At this stage, transmission line filters are introduced, leading to a consideration of tuning systems for microwave receivers and an adequate discussion of detectors, mixers, local oscillators, and intermediate frequency amplifiers. In conclusion, some examples of receiver circuits and associated measuring equipment are given, together with a supplementary bibliography of recent articles relating to the matters discussed.

The difficulties confronting the editors of a book of this nature, which covers a wide field in great detail, are admittedly formidable, and much thought has obviously been given to the arrangement and integration of the various sections. Nevertheless, there is some repetition of material in the separate contributions which could have been avoided had the basic work been presented in certain chapters of a general introductory character. The second chapter, dealing with ultra-high-frequency measurements, might well have served as an introduction to the section devoted to antennæ arrangements, while discussion of the latter prior to a consideration of the methods of generating and detecting very high-frequency waves appears to be somewhat out of place.

Some of the subject-matter has already appeared, scattered throughout the technical literature of the past few years, and the authors are to be complimented for having produced in an integrated form the information and experience which they and their colleagues have gained during the war-time years of intense activity in the microwave field. Also, some of the material is new, and as such constitutes a valuable addition to the knowledge of these recently acquired techniques.

Having been compiled by a group of specialists, the book is essentially practical in content, and the experimenter will undoubtedly find therein many useful guides towards the design and successful operation of his apparatus; this, in a more academic treatise, might have been overlooked.

Although the reader may sometimes be critical of the way in which the material is presented, he will not dispute that the numerous techniques are discussed in a complete and concise manner. The authors are clearly masters of the methods which they describe, and many readers will be grateful to them for having produced this detailed account of their technical experiences.

JOHN LAMB

THE PIGMENTARY EFFECTOR SYSTEM

Animal Colour Changes and their Neurohumours

A Survey of Investigations, 1910–1943. By George Howard Parker. Pp. x + 377. (Cambridge: At the University Press, 1948.) 30*s*. net.

THIS is a very valuable compilation of literature on chromatic function which, together with previous reviews by Fuchs (1910) and Hogben (1924), makes readily accessible all references on the subject from antiquity to recent times. The introductory chapter deals with distribution and types of chromatophores, with their activities and methods of measuring them. This is followed by a systematic survey of chromatic response in cephalopods, Crustacea and cold-blooded vertebrates; seasonal coat changes in birds and mammals are not discussed. The final chapters consider development, genetics and 'special activities' of vertebrate chromatophores. The bibliography of more than 1,200 titles is conveniently arranged under three heads, namely, survey publications (chiefly historical) before 1910, and complete list from 1910 to 1943 inclusive. As have learned to expect from Prof. Parker, the scrip is lucidly and persuasively written.

This review is particularly valuable at prese because, despite Prof. Parker's modest disclaim is evident that he has had access to much mate that has escaped the notice of most British worke during the war years. But this work is, of course much more than a compilation, and woven into th review is the author's well-known neurohum interpretation of pigmentary activity. The criti part of the work is clearly, and for the most p impartially, stated, but it calls for criticism on sev counts.

The introduction makes it clear that Parker is n less intransigent with regard to the value of t Hogben melanophore index for obtaining da essential for critical judgment on certain disput issues; but his criticism of Neill's work on t ground that he confused 'morphological' and 'phys logical' changes makes it equally clear that the va of the melanophore index for discriminating betwe these two types of change has escaped him. Nei used the melanophore index and consequently h plottings represent physiological change only.

From a statement on p. 104, in which Prof. Par says the *W*-hormone "appears to be the effective ag in the blanching of many elasmobranchs", it wou appear that he has weighed the evidence for the t hormone ('*B*' and '*W*') hypothesis and is now n sympathetic towards it, but on p. 206 we find t because "the blood of a normally pale frog wh injected into a dark one will not cause the dark to blanch", he concludes that "the blood of a norm blanched frog contains no agent concerned with concentration of its melanophore pigment" shows (as is admitted by implication on [illegible] to grasp the full implications of the two-hormo hypothesis. According to this hypothesis, on a bla background '*B*' is being secreted maximally, and a white background both '*B*' and '*W*' are secret maximally; but (as shown by melanophore in readings) '*W*' does not fully override '*B*'. Hence, intact pale animal will never have an effective ex of '*W*' and so it could not be demonstrated in the w proposed by Parker.

Prof. Parker has re-stated his experiments on n cutting. The novel feature of his interpretatio these is his belief that when nerves are cut in a teleost the dark bands evoked are due to persi prepotent stimulation of 'expanding' fibres. M ingeniously devised evidence is marshalled in fav of this view and it may well prove correct; bu quantitative study after similar procedures on hy physectomized fish would dispose (or otherwise) o simpler interpretation, namely, that when releas from nervous stimulation the melanophores expa under the influence of pituitary hormones in cir lation.

Parker's writings on neurohumoralism fall into distinct categories: (*a*) experiments on teleost spec in which there is undoubtedly 'direct' nervous co trol of melanophores—it is claimed that nerve endi in close proximity to the melanophores influ their effectors by liberation of neurohu arguments to show that there is no valid distinct between humoral and nervous co-ordination. melanophores are influenced by the liberation drug-like substances (neurohumors) from nerve er ngs in close proximity to them, the fact is of considerable physiological importance and Parker's work this connexion is of great interest. But co-ordination by a blood-circulated hormone has different physiological attributes from nervous co-ordination ; nd it is therefore a purely verbal compromise between issues which are not factually consistent to aim that in the light of the neurohumoral hypothesis he distinction of a nervous and humoral excitation really vanishes "because both rely for their effectiveness on liberated substances which from a near or r source reach and excite a given colour cell".

The book is attractively produced on paper of unusually high quality. It is certain to remain the andard work on the subject for several years.

H. WARING

NUMERICAL METHODS

he Differential Analyser

y J. Crank. Pp. viii+137+4 plates. (London, ew York and Toronto : Longmans, Green and Co., td., 1947.) 10*s*. 6*d*. net.

Computing Mechanisms and Linkages

By Antonín Svoboda. Edited by Hubert M. James. assachusetts Institute of Technology : Radiation boratory Series, No. 27.) Pp. xii+359. (New ork and London : McGraw-Hill Book Co., Inc., 948.) 27*s*.

THE growing importance of numerical methods in scientific research is reflected in the beginnings f a separate literature. These two books are conrned not with methods, but with tools, and are lcome additions to the small number of books aling with this field. They are both concerned with hat have been called analogue machines, and not digital type of calculator which is now xciting a good deal of attention. Although they are oth concerned with analogue devices, the scope of he two books is very different. Mr. Crank describes e differential analyser, which is used for the solution differential equations, and is purposely designed cover a wide variety of problems, and Prof. Svoboda concerned with the design of simple mechanisms represent specific functions.

Mr. Crank's little book is adequate without being eavy, and not unreasonably expensive. The author orked on the differential analyser at the University Manchester, and later took charge of the very ilar machine at Cambridge. He speaks with the thority of working experience of this equipment, nd the description both of the machine and methods its use is simple and clear. The needs of the search worker who wishes to understand and use e differential analyser have been fully met, so far s they can be without practical demonstration on he machine itself ; and the author goes a long way help the isolated worker, without access to an xisting machine or to experienced guidance, who ishes to design a machine of moderate accuracy nd cost for himself. The amount of useful knowledge acked into this small book is quite remarkable.

Two minor points of criticism, which are rather atters of personal preference, might be noted for a dition. The long list of references at the end f Chapter 6 on 'applications' would be more convennt if arranged in alphabetical order of the authors ; and in his description of the new differential analyser t the Massachusetts Institute of Technology, the author would have done well to include a reference to Prof. S. H. Caldwell's D.Sc. thesis ; in this thesis there are also some interesting remarks on method which should not be forgotten.

Prof. Svoboda's book is No. 27 of the Massachusetts Institute of Technology's Radiation Laboratory Series, and is, in fact, an essay in the neglected subject of kinematics devoted to a severely practical need. Prof. Svoboda is concerned with bar linkage mechanisms and their use for the approximate generation of functions required in connexion with fire control, in particular gun predictors. He shows that with two basic mechanisms, the harmonic transformer and the three-bar linkage, it is possible to perform the fundamental operations of arithmetic, addition, subtraction, multiplication and division, and to generate ballistic functions. The interesting point that arises in this book is that although the field of functions which can be generated exactly by a combination of these two mechanisms is limited, if one is satisfied with an approximate description and works to definite tolerances, a wide variety of functions can be generated within these limits of accuracy. Prof. Svoboda describes a definite design method. He shows how a crude approximation may be refined in successive stages until the desired degree of accuracy is reached.

The theory of these mechanisms is fully developed in the book, and excellent charts and tables are given for those who wish to use its methods. The book also has the virtue of being complete in itself. Although well written and clearly expressed, it might be difficult reading for the engineer. Nevertheless, the reviewer is convinced that the theory here developed will have useful engineering applications apart from the war-time applications described.

JOHN WOMERSLEY

WILD ANIMALS AND THE LAND

Wild Animals and the Land

By F. Howard Lancum. Pp. 136 + 29 plates. (London : Crosby Lockwood and Son, Ltd., 1947.) 10*s*. 6*d*. net.

MR. HOWARD LANCUM in this book writes primarily for men of the land who wish to know something of the status of British wild animals in relation to agriculture, horticulture and food production, and has produced an attractive book, illustrated by excellent photographs. Some of the animals he describes are the fox, the badger, the otter, rabbit and hare, the hedgehog and squirrel, rat, vole, mice and shrew. It is good to see that he mentions the good, as well as the harm, animals do. For example (p. 32), we are told of the fondness of the badger for wasps' grubs. When a wasps' nest had to be tackled, "it was a common occurrence for a deputation of youngsters to present itself at the door of the house of Brocky's [the tame badger's] master, with the request, 'Can we borrow Brocky, please ?' Brocky was ever ready to be borrowed, for none knew better than he what was afoot. He would be duly led away with collar and chain until the company came within sight of the offending wasps' nest. As soon as he saw the flying wasps his hackles would rise, and he was released from the chain while the children remained at a safe distance. In an almost incredibly short time Brocky would have that nest out of the ground, and would be feasting royally on fat, juicy wasp grubs, meanwhile uncaring for, or impervious to, the stings of the outraged wasps."

The author (p. 33) has investigated during his life nearly a hundred supposed instances of the killing of poultry by badgers, and in only two instances was it possible to prove that the damage was the work of badgers—in most of the other instances he discovered that a fox was the culprit. He therefore makes a strong plea for the better protection of this, one of the most attractive of British mammals. He mentions (p. 57) that owing to the setting of its eyes the hare is often unable to see right ahead of it. I recall a remarkable example of this in the blue hare, which on one occasion allowed three persons to approach and photograph it in the open without apparently being aware of their presence; then, after about half an hour, became suddenly conscious of it and rushed off in a panic. Hares, usually timid, can be brave in defence of their young, and on page 59 the author mentions that on a memorable occasion he saw a doe hare kick a stoat to a distance of several feet. His account of a squirrel 'freezing' (p. 64) on the appearance of a buzzard seems to point to the fact that the buzzard, like the golden eagle, may on occasion take squirrels for food. I recall a pair of golden eagles which regularly brought squirrels to the eyrie for food for their two eaglets.

Mr. Lancum's account (p. 73) of a stoat swimming reminds me that on one occasion when fishing I saw a stoat unhesitatingly take to the water on a cold spring day in order to avoid a scramble up a grassy bank. The author has a good word even for the stoat, because it can kill a rat without difficulty, and kills mice in great numbers.

SETON GORDON

UP-TO-DATE TREATMENT OF VENEREAL DISEASES

The Venereal Diseases

A Manual for Practitioners and Students. By Dr. James Marshall. Second edition. Pp. xvi+370. (London: Macmillan and Co., Ltd., 1948.) 21*s*. net.

Of making many books there is no end, but this is not true of text-books on venereal diseases published in Great Britain; for this reason Dr. Marshall's manual is particularly welcome, more especially as it is full of sound teaching which should be valuable both to the student and to the practitioner. Venereal diseases have been with us since time immemorial, nor have they changed very much; but their treatment is constantly changing, and this has been most marked since the introduction of the sulphonamides and penicillin. No doubt this was largely the reason for the production of a second edition so soon after the first. This second edition contains a number of minor changes and improvements, but is of chief importance in that it brings the therapeutic use of penicillin up to date and at the same time introduces new matter on intensive and semi-intensive arsenotherapy, non-gonococcal urethritis, which was so prevalent in most armies during the War, and Reiter's syndrome, which, if it is not venereal in origin, certainly brings many patients to venereal diseases clinics. Those who are not familiar with this condition will do well to read what Dr. Marshall has to say about it, because no doubt it is one which has been frequently missed in the past and is probably commoner than many suppose; moreover, treatment is far from satisfactory, and patients are often rendered incapable of work for many weeks by the painful arthritis which is one of the prominent features.

What will appeal most to readers, however, is the latest information about the use of penicillin in treating venereal diseases; for the treatment of acute gonorrhœa the author prefers four or five injections, each of 50,000 or 40,000 units in aqueous solution, given at intervals of three or two hours, though he admits that a single injection of 300,000 units in oil-wax suspension is permissible, and no doubt this is much the most convenient method in a civilian venereal disease clinic, because few patients are willing or able to wait several hours or visit a clinic several times in one day. The objection to the penicillin treatment of gonorrhœa is the risk of masking a concurrently acquired syphilitic infection; by no means all patients can be relied on to attend regularly for blood tests for a period of six months. For this reason there is much to be said for treating acute gonorrhœa with sulphonamides and only resorting to penicillin if these fail. Where complications are present, much larger doses of penicillin are necessary, and in such cases it is pointed out that there is a good deal to be said for giving an amount, such as 3 mega units, which will have a reasonable chance of curing an incubating syphilis.

For the treatment of early syphilis it is recommended that arsenic, bismuth and penicillin should be employed concurrently; ten weeks of arsenic and bismuth together with 3 mega units of penicillin in aqueous solution by means of three-hourly injections —but for ambulant patients, and these will represent the vast majority of cases, he advises 300,000 units in oil-wax daily for ten days.

Very wisely the views expressed concerning the treatment of late syphilis, including neuro-syphilis, are extremely guarded because not enough time has yet elapsed to assess results; but, in general, penicillin in heavy dosage is recommended in addition to arsenic bismuth and, if necessary, fever.

Of the arsenicals, mapharside or neohalarsine is preferred to neoarsphenamine if the patient can attend for injections twice weekly; in this the author tends to follow American rather than British custom; the two former may be safer from the point of view of toxic reactions, but it is doubtful if they are as therapeutically effective as neoarsphenamine, and there are many advantages, particularly from the patient's point of view, in attending only once weekly. Non-gonococcal arthritis is so common and so difficult to cure that many readers would welcome more details of treatment, and much the same applies to *Trichomonas vaginalis* infestation, which may account for half the attendances at a female clinic; no doubt limitations of space had to be taken into account, for it must be very difficult to deal adequately with all the venereal and allied conditions in the space of three hundred and fifty pages. The average reader is not concerned with the structural formulæ of the various arsenicals and sulphonamides: the omission of these would give room for matter of more practical interest.

If this book is not a literary masterpiece it is certainly full of sound teaching, gives the practitioner all the information which he requires for the management of his patients suffering from venereal diseases, and, if carefully studied, will get the student through his examinations; the section devoted to "Practical Instructions" is particularly helpful.

T. E. OSMOND

Introduction to the Theory of Equations

By Assoc. Prof. Lois Wilfred Griffiths. Second edition. Pp. ix+278. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1947.) 18*s.* net.

THE contents of this volume fall into three clearly marked sections. Chapters 1–4 (pp. 1–105) lead up to the location and calculation of the real roots of a real algebraic equation; the cubic and quartic equations are studied in Chapter 2, as a preliminary to theorems on the general equation. Sturm's theorem provides for locating the roots of the general equation, but the only method of calculation expounded is that of Horner, explained very lucidly with attention to the justification of contracted processes. Chapters 5–7 (pp. 106–235) deal with determinants, introduced for orders 2 and 3 and extended to order *n*, and with systems of linear equations. The connexion between a set of solutions of such a system and the rank of the augmented matrix of the system is set out carefully; but some hints on what can be done to alleviate the tedious process of solving a numerical set of linear equations would have been welcome. Chapter 8 sets out the axiomatic theory of the complex number, familiarity with the technique having been assumed in the early chapters. Chapter 9 deals with symmetric functions of the roots of an algebraic equation, a topic the academic elegance of which has caused it to be over-elaborated in some text-books; Prof. Griffiths rightly relegates it to the subordinate position it should occupy in an introductory account.

Chemical and Physical Investigations on Dairy Products

By H. Eilers, R. N. J. Saal and M. van der Waarden. (Monographs on the Progress of Research in Holland.) Pp. xv+215. (New York and Amsterdam: Elsevier Publishing Co.; London: Cleaver-Hume Press, Ltd., 1947.) 21*s.* net.

THE series of publications, of which this book on dairy research is one, deals with the investigations carried on by Dutch scientific workers during the German occupation of the Netherlands. The Dutch are a pertinacious people, and the 'mere trifles' of enemy occupation, oppression and near-starvation do not seem very seriously to have depressed the high quality, although they may have somewhat diminished the quantity, of their research in dairy chemistry and physics.

This volume contains, in effect, three communications. The first, by Eilers, deals with the colloid chemistry of skim milk, and includes studies of the calcium-casein-phosphate complex, the proteins in milk denaturable by heat, and the physical and physico-chemical changes occurring in skim milk on concentration. The second, by Saal and Heukelom, is concerned with the oxidation-reduction potential of the complicated biological system of milk and the only slightly less difficult system of butter-plasma. The third, by van der Waarden, approaches the commercially important, as well as academically interesting, group of problems associated with the chemical processes underlying the deterioration of butter.

Each article provides a short but well-documented survey of the field (though for obvious reasons there are few references after 1939) and each presents a considerable body of original research. This well-written and eminently readable volume is commended to every chemist or physical chemist interested in dairy research or dairy technology. H. D. K.

The Skyscraper Hive

By Father M. Dugat. Authorized translation of "La Ruche Gratteciel à Plusiers Reines" by Norman C. Reeves. Pp. xvi + 78 + 4 plates. (London: Faber and Faber, Ltd., 1948.) 8*s.* 6*d.* net.

ALTHOUGH no competent beekeeper is likely to disagree with the general statement that "The secret of large surpluses (of honey) is large colonies", a good many beekeepers will heartily disagree with M. Dugat's system of colony management. His system is indeed little more than an extension of the two-queen system of management which has been tried out very thoroughly in the United States and other countries since at least the beginning of this century, and has not been found to yield any notable increase in honey crop *per queen* over various single-queen systems.

All the data at present available as a result of much experimentation lead one to suggest that the success which M. Dugat has achieved is not so much due to his multi-queen system as to those other methods of management which he employed with his 'skyscraper' hives, and which are equally applicable to single-queen colonies. Such methods, which involve the partial separation of young bees from the older field bees and, by giving the queen every encouragement to lay to her full capacity, lead to the development of very powerful colonies, and at the same time help to control swarming, have long been known to give good results.

One cannot help but feel that M. Dugat might have obtained even larger crops of honey if he had avoided the once popular but now largely discredited practice of completely de-queening his colonies just before the honey-flow, a practice which frequently results in a loss of what may perhaps be termed 'colony morale'. COLIN G. BUTLER

Principles and Practice of the Rorschach Personality Test

By W. Mons. Pp. 164. (London: Faber and Faber, Ltd., 1947.) 12*s.* 6*d.* net.

SINCE the Swiss psychiatrist, H. Rorschach, published his fascinating "Psychodiagnostik" in 1932, considerable effort has been devoted in several countries to elaborating the methods of scoring and interpreting the test responses. Nevertheless, the somewhat forbidding notation in current use has given the accumulated mass of data the semblance of esoteric lore and the test itself has acquired what the late William Stern called a "monosymptomatic despotism". It is refreshing, therefore, to read Dr. Mons' clear and restrained account of the techniques and interpretation of the Rorschach 'ink-blot' test, an account based on extensive experience with Service and civilian patients and on the examination of a thousand clerical records.

With the difficulties of the novice in mind, Dr. Mons painstakingly explains how to administer the test, how to classify the responses according to a widely used, though somewhat pretentious, notation, and how to evaluate the significance of the responses so as to yield an assessment of the personality, particularly its 'structural' features. Several new formulæ useful for diagnostic purposes are suggested.

It is to be hoped that this useful manual will stimulate workers to pursue much more rigorously than hitherto methods of validating the test which could greatly improve its potential value as a diagnostic tool. JOHN COHEN

SPECIFIC CRYSTALLINE PROTEIN AND NUCLEOPROTEIN FROM A PLANT VIRUS HAVING INSECT VECTORS

By Dr. ROY MARKHAM, Dr. R. E. F. MATTHEWS
AND
Dr. KENNETH M. SMITH, F.R.S.
Agricultural Research Council, Plant Virus Research Unit, Molteno Institute, University of Cambridge

Introduction

IT is now more than ten years since Bawden and Pirie[1] showed that the tobacco mosaic virus is a nucleoprotein. Since that date several other plant viruses have been isolated, and as all seem to be nucleoproteins, the nucleoprotein nature of viruses has been widely accepted.

From plants infected with the turnip yellow mosaic virus[2,3], we have isolated and crystallized both a nucleoprotein and a protein free from nucleic acid, both specific to the disease and similar in many ways. In this virus disease we appear to have a borderline case, a naturally occurring link between the virus proteins and the non-virus proteins, and we have obtained direct evidence for the widely held belief that nucleic acid is essential for the multiplication of plant viruses.

The turnip yellow mosaic virus is also of interest in its mode of transmission. As already reported[4], it is unique among crystallizable viruses in being transmitted by an insect—and a biting insect at that. It now appears that it may be transmitted by a large variety of insects provided that they have biting mouth parts and, apparently, no salivary glands. The insect-virus relationship does not seem to be purely mechanical, as a preliminary delay in the development of infective power of about one day is usually necessary. Using purified virus mixed with sucrose, it is possible to feed the insects artificially and to study the host-virus relationships in this way.

Properties of the Virus Proteins

The original method of purification of the turnip yellow mosaic virus described by Markham and Smith has been found unsuitable during the summertime, so a simpler method has been developed which is reliable at all times of the year and is not dependent upon the temperature of the laboratory. The sap from turnip or Chinese cabbage is clarified by the addition of exactly 300 ml. of 90 per cent alcohol to each litre, followed by spinning. Under these conditions the virus is still in the supernatant liquid, and is precipitated from it as octahedral crystals by the addition of half a volume of saturated ammonium sulphate solution. Further purification may be effected by recrystallization from salt solutions, a large number of salts being suitable for this purpose, all depositing the virus as octahedra, or by recrystallization from an acid solution (pH 3·8) of the virus in 20 per cent ethyl alcohol. The latter crystallization must be carried out in the cold at a temperature of 5° or less. The virus is then deposited as fine needles which frequently form globular clusters. These pack down on the bottom of the container, and after a couple of days the mother liquor may be decanted without loss of crystals. Yields of as much as 1 gm. per litre of sap have been obtained from field turnips by these methods.

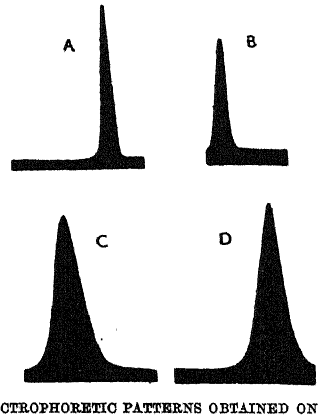

Fig. 1. ELECTROPHORETIC PATTERNS OBTAINED ON THE TISELIUS APPARATUS: CONCENTRATIONS 5 MGM./ML. *A* AND *B* STATIONARY AT pH 3·78 AFTER 3 HR. AT 2·33 VOLTS/CM. *C* DESCENDING AND *D* ASCENDING AT pH 4·16 AFTER 5 HR. AT 5·48 VOLTS/CM.

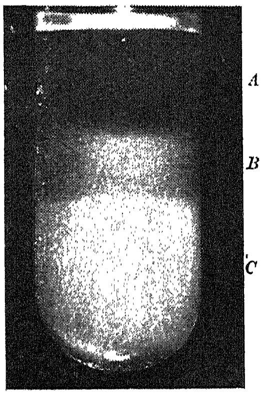

Fig. 2. CELLULOID CENTRIFUGE TUBE AFTER SPINNING AT 12,000 R.P.M. FOR TWO HOURS, PHOTOGRAPHED BY LIGHT SCATTERED FROM VIRUS PROTEINS. *A*, SOLVENT LAYER; *B*, VIRUS PROTEIN; *C*, VIRUS PROTEIN PLUS NUCLEOPROTEIN

Virus preparations of this type are highly infectious and are quite uniform in composition. They contain some 15 per cent nitrogen, 2·15 per cent phosphorus and 5 per cent of purine-bound pentose, the latter two being entirely in the form of nucleic acid. On electrophoresis the solutions are isoelectric at pH 3·75 and contain only one homogeneous component at several pH's (Fig. 1). The examination of this material in the ultracentrifuge, carried out by R. Cecil and A. G. Ogston at Oxford, revealed the presence of two components differing in the ratio of about 1 : 2 in sedimentation constant, the slower or 'top' component comprising some 20 per cent of the whole.

The Oxford workers were kind enough to prepare for us about 8 mgm. of pure (95 per cent) top component using the separation cell of Tiselius, Pedersen and Svedberg[5]; and when we examined it, it was evident that the top and bottom components were different in some of their chemical properties.

Eventually we found that, when solutions containing more than 10 mgm./ml. of virus-protein were spun in a Sorvall S.S.1 centrifuge, boundaries formed (Fig. 2) and were sufficiently stable to allow the top component to be removed by a pipette. The material so obtained is only 75–80 per cent pure top component, but this purity may be increased to 80–85 per cent by a second spin. In this case only the top boundary forms, and the top half of the solution is sampled.

By this means we were able to prepare large quantities of the top component in a state of purity sufficient for most work, and in a similar way we have increased the purity of the bottom component to 90–95 per cent.

Top and bottom components of turnip yellow mosaic virus are similar if not identical in the following respects. Both crystallize from salt solutions as octahedra (Fig. 3) and under the electron microscope are spheres of similar size, while they both can form micro-crystals on the electron microscope grids (Cosslett and Markham[6], and unpublished). In solution, too, they seem to be the same size, and both are resistant to digestion by pancreatic enzymes. The bottom component, however, is the only one containing nucleic acid, and the absorption spectra of the two are consequently very different (Fig. 4). Although complete amino-acid analyses are not yet available, preliminary paper chromatography[7] using several solvents indicates that both proteins contain the same amino-acids in similar proportions. All the evidence which we have suggests that the protein parts of both components are identical and that the bottom component differs only in having some 28 per cent of pentose nucleic acid by weight embedded in it in such a way that it takes no part in forming the electrostatic surface of the molecules. The comparatively acid isoelectric point of both proteins seems to be due to the relative preponderance of the dicarboxylic amino-acids in the protein, a fact which may seem in contradiction to the orthodox conception of nucleoproteins. The top component is therefore the first native virus protein which has been obtained free of nucleic acid.

By comparing the properties of these two proteins, we have discovered two distinct biological functions of nucleic acid in a plant virus nucleoprotein. First, all the infectivity of our preparations appears to reside in the nucleoprotein fraction, since the top component, even when freshly prepared, does not seem to be infectious. However, experiments using different isolation techniques which control the effects of our isolation procedure at each stage indicate that infection with the nucleoprotein results in the production of the top component as well as a larger quantity of nucleoprotein. As yet we can only speculate as to the origin of the top component. It may represent a stage in the synthesis or the breakdown of the nucleoprotein, or might even be the result of an abortive attempt at multiplication. Secondly, a single intravenous injection into rabbits of as little as 0·01 mgm. of the nucleoprotein results in the production in a fortnight of a precipitating serum of titre about 1 : 16. Sera of extremely high antibody content result after injection of larger quantities. On the other hand, the top component is very much less antigenic, the antibody production in response to an injection being not appreciably greater than could be accounted for by the small but inevitable quantity of nucleoprotein contaminating even our best preparations. When solutions of the two proteins are made up in equivalent concentrations, however, it is not possible to distinguish between them by means of antisera produced in response to the injection of the nucleoprotein.

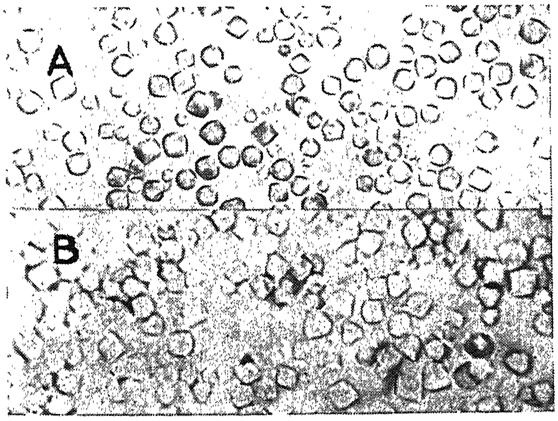

Fig. 3. *A*, CRYSTALS OF TURNIP YELLOW MOSAIC VIRUS PROTEIN ; *B*, CRYSTALS OF THE VIRUS NUCLEOPROTEIN

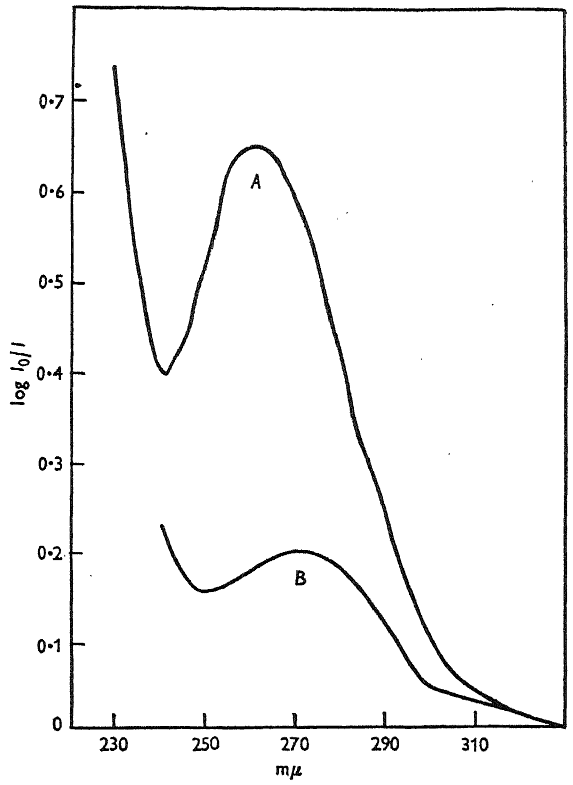

Fig. 4. ULTRA-VIOLET LIGHT ABSORPTION SPECTRA OF WHOLE VIRUS PREPARATION, *A*, AND TOP COMPONENT, *B*, AT A CONCENTRATION OF 0·1 MGM./ML. IN A 1-CM. CELL

Using several antisera from different rabbits, the times for precipitation and the position of the optima are the same for both components. Over a range of antiserum–virus protein ratios in the region of antibody excess, the weight of antibody combining with unit weight of *protein* is the same within the limits of the experimental methods. Thus there is no indication that there are any antigenic groupings in the nucleoprotein in which nucleic acid is involved. This is difficult to reconcile with the fact that presence of the nucleic acid greatly enhances the power of the protein to stimulate antibody production.

Although the two proteins are found in our preparations, we have been unable to convert the nucleoprotein into native protein plus nucleic acid. In every case where nucleic acid is liberated, the protein is denatured. It is of interest to note here that the protein is denatured in the cold at *p*H 7 in solutions containing more than 30 per cent alcohol by volume, and the nucleic acid is left in solution. When prepared in this way, the nucleic acid solutions evidently contain large thread-like molecules, and if the concentration is as much as a few milligrams per millilitre they set into jellies. In this way the nucleic acid resembles that of tobacco mosaic virus[8]; but the method of isolation is even less drastic and is, in fact, the mildest method for the isolation of a pentose nucleic acid which we know.

Insect Relationships of the Virus

The method of transmission of this virus in the field differs from that of all other known plant viruses, the insect vector being a flea beetle (*Phyllotreta* spp.) with biting mouth parts instead of the usual sap-sucking type of insect, such as aphides or leaf-hoppers. This is also the first time a crystallizable plant virus has been shown to have an insect vector. The relationship between the virus and the insect which transmits it has not yet been completely worked out, but certain interesting facts have been elucidated. Whereas in Nature the transmitting insects are one or more species of flea beetle which feed on the turnip plant, under experimental conditions several entirely different types of insect will transmit the virus. These include three or four species of beetles, including *Phœdon cochleariœ*, the mustard beetle and its larva, the common earwig and two species of grasshoppers. These insects have, however, one characteristic in common, namely, they all have biting mouth parts. A large number of transmission experiments, mostly with the larva of the mustard beetle, including some using artificial feeding methods, have been carried out. For the artificial feeding the larvæ were desiccated slightly by starving them for twenty-four hours. They were then allowed to feed upon drops of purified virus solution to which had been added a little sucrose.

These experiments have shown that, as a rule, an insect does not become infective after feeding on a source of virus until after the lapse of a period of 24–48 hours. On the other hand, there are exceptions to this, in which the processes of feeding on the source of virus and infecting the healthy plant can be carried out in a total period of ten to fifteen minutes.

For these two types of virus transmission, we suggest the following explanation. The rapid type of infection can be explained on the assumption that the mouth parts are contaminated with virus which is thus passively transferred to the healthy plant. Some other explanation, however, is necessary for the delay of 24–48 hours before infection and the subsequent retention of infective power by the insect for one or two days more. It seems to be a fact that most beetles and their larvæ do not possess salivary glands, and digestion of plant tissue is aided during mastication by regurgitation of some of the contents of the foregut. During this process some of the virus previously ingested would be brought into contact with the healthy tissue and thus cause infection of the plant. This would explain both the delay in the development of infective power and the retention of the ability to infect. Some support for this hypothesis is given by the fact that in most of the transmitting insects, besides the beetles, the salivary glands appear to be missing or rudimentary.

Detailed accounts of this and other work on this virus will be published elsewhere.

Our thanks are due to Mr. R. Cecil and Dr. A. G. Ogston for their co-operation in this work.

Summary

(1) Some of the unusual properties of turnip yellow mosaic virus are described.

(2) This virus is transmitted by biting insects only, and there appears to be a correlation between the ability of an insect to transmit the virus and the absence of salivary glands which necessitates regurgitation of the contents of the foregut. Artificial feeding methods have been successful.

(3) Two proteins have been isolated from plants infected with this disease and both have been crystallized. One is a nucleoprotein containing 28 per cent of pentose nucleic acid, and the other appears to be the same protein without the nucleic acid.

(4) The nucleic acid may be obtained from the virus by a method milder than any so far employed for the isolation of a pentose nucleic acid. The nucleic acid is a very large molecule, probably rod-shaped.

(5) It is not possible to differentiate between the two proteins by means of serological precipitation, but, when injected into rabbits, the nucleoprotein is many times as antigenic as the protein.

(6) Only the nucleoprotein is infectious to plants, and the presence of combined nucleic acid would appear to be necessary for virus multiplication.

(7) Both proteins are the same size and shape and have identical electrophoretic mobilities.

(8) This is the first time that a virus protein has been obtained in a native condition, free from nucleic acid.

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[2] Markham, R., and Smith, K. M., *Nature*, **157**, 300 (1946).

[3] Markham, R., and Smith, K. M., *Parasitology* (in the press).

[4] Smith, K. M. and Markham, R., *Nature*, **158**, 417 (1946).

[5] Tiselius, A., Pedersen, K. O., and Svedberg, T., *Nature*, **140**, 848 (1937).

[6] Cosslett, V. E., and Markham, R., *Nature*, **161**, 250 (1948).

[7] Consden, R., Gordon, A. H., and Martin, A. J. P., *Biochem. J.*, **38**, 224 (1944).

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CHEMICAL RESEARCH LABORATORY, TEDDINGTON

THE Chemical Research Laboratory of the Department of Scientific and Industrial Research has again held a very successful series of 'open days'. On June 29 the Laboratory was visited by the Lord President of the Council, Mr. Herbert Morrison, who was received by Sir Edward Appleton, secretary of the Department, Dr. R. P. Linstead, director of the Laboratory, and Sir Norman Haworth, chairman of the Chemistry Research Board. During the remainder of the week there were nearly a thousand visitors, including chemists from industry, university laboratories, technical colleges, research and trade associations and Government establishments. These visits serve to keep the chemical community aware of the work of the Laboratory, and enable problems of common interest to be discussed. They supplement the published reports of the Laboratory and its Advisory Board. It may be noted that the reports for the years 1938–46 have recently appeared*.

The exhibits on view in the Laboratory covered the whole range of its activities, which include organic chemistry; inorganic chemistry, including radiochemistry; corrosion of metals, including microbiological corrosion, and high polymers and plastics. The semi-scale laboratories and engineering workshops were also open to inspection.

The research work of the Corrosion Section attracted a large number of visitors. The main equipment of the Section, namely, the high- and low-speed rotor assemblies and the moving-belt apparatus for achieving accelerated corrosion, were on show. In the field of atmospheric corrosion, attention was particularly directed to a new 'condensation' type of test whereby comparisons can be made of protective methods; also to studies of special alloy steels. Electrochemical studies of immersed corrosion were on view, and recent advances in the technique of stripping natural protective films were demonstrated. Interesting discoveries have recently been made at the Laboratory on organic corrosion inhibitors. The inclusion of these in cooling liquids for internal combustion engines and wrapping materials was demonstrated. A particularly interesting exhibit showed the incorporation of an organic inhibitor into rubber latex.

The Microbiology Section illustrated the problem set by the external corrosion of iron pipes in clay soils. This is especially serious to-day because of the extensive post-war programme for laying rural water mains and gas and water systems for new housing estates. The virulent type of corrosion which occurs in clay is due primarily to the activity of anaerobic sulphate-reducing bacteria. Recent work at Teddington suggests that these bacteria may also be responsible for much of the internal corrosion experienced with soft moorland waters. The exhibits illustrated the fundamental properties of the bacteria, which are facultative autotrophs. Their remarkable morphological changes were shown by electron micrographs. Laboratory and field work on protective measures were also demonstrated.

Research in organic chemistry at the Laboratory covers a wide field, and investigations in coal tar have been in progress for more than twenty years. This work is now being concentrated in three directions. One group is concerned with the isolation and identification of the individual constituents of various coal tar fractions. For this purpose extensive use is made of high-efficiency fractional distillation. A notable exhibit comprised a battery of packed distillation columns all operating at pre-selected constant pressures and capable of a very high standard of performance. A second team is concerned with the collection of fundamental reference data for pure compounds.

Chemical processes and the design of chemical plant depend to-day to an ever-increasing extent on the availability of reliable physico-chemical data. These are very scanty in the field of coal tar constituents, and this part of the Laboratory's programme aims at filling the gap. Research in this field was illustrated for pyridine of 99·9 per cent purity. The composite all-glass apparatus used for the manipulation and transference of pure compounds under vacuum and for the measurement of boiling point, freezing point, vapour pressure, etc., was on view. This equipment incorporates an automatic barostat which will maintain pressures constant to at least 0·025 mm. mercury. Other apparatus displayed included an automatic recorder for freezing point determination and an ebulliometer, both of which employ a thermistor for the detection of small temperature changes. In this way differences of temperature of 0·001° C. can readily be recorded, and the equipment can be applied to the measurement of chemical purity. One exhibit which excited special interest was a miniature platinum resistance thermometer capable of reading temperatures to 0·001° C. This has been constructed in collaboration with the Physics Division, National Physical Laboratory.

The objective of the third group is to develop new industrial outlets for neglected constituents of coal tar. This was illustrated by work on the dehydrogenation of acenaphthene and the conversion of the product, acenaphthylene, into polymers of interest to the plastics industry. Among the exhibits by this group was a reference collection of more than a hundred pure coal tar compounds.

The Laboratory is now preparing to synthesize organic intermediates on a small scale in order to assist in the application of isotopic tracers to chemical, medical and biological problems. Work is in hand on both heavy and radioactive carbon; this involves the synthesis of useful compounds from simple carbon sources such as barium carbonate or potassium cyanide in which a proportion of the carbon consists of C^{13} or C^{14}. Syntheses with the radioactive isotope C^{14} have been undertaken in collaboration with the Radiochemical Centre, Amersham, members of the staff of which are at present working at Teddington. The elaborate apparatus required for these studies was on view; it demonstrated the value of the Laboratory's skilled glass-blowing service.

Other exhibits in the organic chemical field illustrated the part played by the Laboratory in the early development of the new synthetic fibre 'Terylene' (polyethylene terephthalate). The work of the Laboratory in the preparation and purification of methyl-silicon intermediates was illustrated and samples of a heat-resistant material were on show. The ability of methyl chlorosilanes to render glass and cellulose water-repellent were strikingly demonstrated.

Inorganic chemistry has of late been a comparatively neglected branch of the science; but many recent technological developments, including the discovery of atomic energy, have helped to revive interest greatly. This revival was illustrated at the Laboratory by a number of exhibits, prominent among which was one on recent work on the analytical chemistry of uranium and thorium. Examples of the increased interest in very pure and less common metals were provided by exhibits of recent work on pure vanadium, gallium and germanium.

Great interest was shown by visitors in the Laboratory's work on high polymers and plastics. Recent research on ion-exchange resins, originally discovered at Teddington in 1935, was illustrated. An attractive exhibit showed the preparation of sulphonated cross-linked polystyrene in bead form. Work on the problem of swelling of polymers, and on the mechanical properties of reinforced plastics, was also on view; and the very successful recent development of synthetic adhesives at the Laboratory was illustrated.

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* Chemistry Research, 1938 to 1946. (London: H.M. Stationery Office.)

Special attention is given at the Laboratory to the development of physical and other special techniques of general usefulness. This was illustrated by demonstrations of spectrographic equipment, including a double-beam infra-red spectrograph, radiometric methods, microanalysis, chromatography, polarography and other modern techniques.

IMMUNITY TO VIRUS DISEASES

On July 1 at Cambridge, during the course of the scientific meeting of the British Medical Association, the Section of Pathology discussed "The Prophylaxis of Virus Infections with Special Reference to the Use of Vaccines".

For some human virus infections, such as rubella and infectious jaundice, there is not yet available a susceptible laboratory animal—or even a susceptible egg!—and vaccines are thus at present unattainable. For others, such as (within limitations) influenza, inactivated vaccines are available; these are safe, but do not give enduring immunity. For others, such as smallpox and yellow-fever, living attenuated viruses are available, and these give rise to immunity of longer duration. Dr. C. H. Andrewes, who opened the discussion, held up the 17*D* strain of yellow-fever as an example of an ideal vaccinating agent, a standard to which we should like all vaccines to attain. It gives but trifling reactions, and immunity is long-lasting after a single dose. Later in the discussion, however, Dr. G. W. M. Findlay pointed out one flaw in its perfections—a difficulty in preserving its potency without rigorous attention to technique.

Dr. Andrewes devoted chief attention to the complications introduced by the existence of serological races of some viruses, particularly influenza and poliomyelitis. Within the two distinct groups of influenza viruses, *A* and *B*, there exist serological races, sufficiently divergent to be of importance from the points of view of epidemiology and vaccine-prophylaxis. Very potent vaccines can be made from embryonic fluids of infected fertile eggs, inactivated with formalin. In 1943 such vaccines effected fourfold reduction in the incidence of influenza *A* in trials in a number of centres in America; in 1945–46 they had done even better in a *B* outbreak, apparently decreasing incidence ten- to twenty-fold. In 1947 they were quite, or almost, useless against the prevailing influenza *A* both in America and in Britain. This failure was almost certainly due to an antigenic divergence of the current *A* strain from those incorporated in the vaccine. More work on the potentialities of the influenza viruses for antigenic variation is necessary, before one can advocate general use of vaccines. In particular, there is ignorance as to whether there are limited numbers of defined types or whether the viruses are antigenically labile; also as to whether 'new' races spread about from country to country. To study this latter aspect, the World Health Organisation has lately set up a World Influenza Centre in London with the function of collecting, distributing and studying strains from all over the world.

Dr. Andrewes briefly discussed the possible application of the 'interference phenomenon' in control of virus infections and mentioned experiments in ferrets by Dr. Gledhill and himself; in these an innocuous influenza *B* strain had suppressed the symptoms of infection by an active *A* strain given within the next two or three days.

Prof. R. Hare, who followed, took a very pessimistic view of the prospects of successful vaccination, particularly against influenza. He emphasized past failures, particularly of vaccine trials in 1947, even going so far as to wonder whether killed viruses would ever be of value in immunizing man. Various methods of improving their activity have been reported—the use of the intradermal route, adsorption on to calcium phosphate and other substances, and mixture with oil. The amount of virus in vaccines has been increased by various concentrating procedures. Yet no consistent success can be reported. Antigenic variation among the viruses further confuses the issue. Prof. Hare felt that, if this is all vaccines made in eggs can do, he would rather have the eggs to eat. Despite his gloom, he did not dispel the thought that if the vagaries of antigenic variation of influenza virus could be understood, the prospects might be a good deal brighter.

Prof. W. I. B. Beveridge, the recently appointed professor of animal pathology at Cambridge, thought that much depends on how effective is the contact between an attacking virus and antibody. Against general infections such as the exanthemata and most insect-borne virus diseases, such contact is good and prompt; immunity is enduring and the possibility of vaccination good. Viruses like the common cold and influenza, which probably never reach the bloodstream, make poorer contacts and the prospects are, therefore, less favourable. He believes that allergy plays an important part in mobilizing the body's defences quickly, and he discussed methods of procuring such a favourable allergic state. Attenuation of viruses to make an effective, safe vaccine is a noble ideal, but is a process difficult to control. There may, as in rinderpest, be a rapid transit from a state of insufficient attenuation to one in which immunizing power also is lost. A degree of attenuation just right for some breeds of cattle may be too drastic or not drastic enough where other breeds are concerned. He thinks that, as regards living viruses, recall or 'booster' doses of vaccine may achieve no immunity-boost unless and until the recipient's immunity has fallen to quite a low level.

Dr. Stoker discussed reasons for failures of immunization against smallpox, such as neglect of many people to be revaccinated after infancy. He particularly stressed that the so-called immune response was an index of sensitivity, not immunity, and should be regarded as equivalent to failure to 'take'. Only with vesiculation accompanying a take of primary or accelerated type does immunity rise satisfactorily. Vaccinia preparations contain an agglutinin for certain red blood cells, and antibodies to this hæmagglutinin develop in immune people. Increase in such anti-hæmagglutinin titres of serum may be a useful guide to what is happening after revaccination. Vaccinia grown in fertile eggs should be given more trials. It is perhaps less stable than calf lymph, but on the other hand could be produced much more rapidly in an emergency. Dr. Stoker also referred briefly to Kaposi's varicelliform eruption, some cases of which he thinks are due to generalized vaccinia in eczematous contacts of vaccinated people. Some of Dr. Stoker's remarks might have afforded useful propaganda for an anti-vaccinationist, had he not begun with the warning that they applied only to failures of vaccination in individuals: its value in inducing herd-immunity was not in doubt.

In the subsequent discussion, Dr. Findlay ranged over several centuries in search of apt news-items about viruses. He also pointed out that yellow-fever immunization in West Africa had been of crucial strategic importance during the Second World War. There was discussion by several speakers of the twenty-year-old theory that immunity persists only while live virus persists in the body—a theory which may be held as a dogma but certainly awaits proof. The role of contaminating hyaluronidase-producing cocci in improving vaccinia 'takes' was discussed by Dr. Lack and others. A number of speakers emphasized that future progress in active immunization against viruses is closely bound up with exploitation of the fertile hen's egg. Progress hitherto has been chiefly noteworthy overseas. Speakers hoped that commercial firms in Britain would see to it that we do not lag behind in this important field of endeavour.

This was an active and useful discussion, not least because, unlike those in some other sections—or so we are told—speakers commendably kept within the prescribed time-limits for their speeches.

OBITUARIES

Sir D'Arcy Thompson, C.B., F.R.S.

When D'Arcy Wentworth Thompson died at the age of eighty-eight, in his home in St. Andrews on June 21, his passing left a gap in many circles that had few points of contact with each other, for he had a wider range of intellectual interests and attainments than almost any other scientific man of our time. By profession he was a zoologist, and there have been few more learned; but he had a quite unusual familiarity with the whole circle of the sciences, joined to an inherited aptitude for, and love of, the classical tongues, and he was constantly surprising his friends by his unexpected knowledge of recondite corners of literature, history and art. He wrote and spoke in a style of effortless felicity, a trifle Victorian perhaps, but, as some of us think, none the worse for that. He loved teaching and he taught to the very last, for even in his final illness he gathered his honours students in his sick-room for talks that none of them will forget.

It is impossible here even to summarize the activities, so varied, of so long a life. He was born on May 2, 1860, at Edinburgh. His father, also D'Arcy Wentworth, was classical master in the Edinburgh Academy and afterwards professor of Greek in Queen's College, Galway; he is still remembered by lovers of a polished style and of liberal ideas on education for his "Day-dreams of a Schoolmaster". His mother, Fanny Gamgee (who died when he was born), belonged to a family distinguished in science and in medicine. After preparatory schooling (which included informal 'Nature study' on Saturday afternoons long before the term was invented) he was sent to Edinburgh Academy, a school the pupils of which have gained fame in all walks of life. He himself has recorded that of his own classmates one was awarded the Victoria Cross, one received a peerage and a seat in the Cabinet, four became fellows of the Royal Society and one a Royal Academician.

On leaving school at the age of seventeen, he matriculated as a medical student in the University of Edinburgh, where he was introduced to scientific zoology by Sir Wyville Thomson, then lately returned from the *Challenger* expedition. But it was with a classical scholarship that, two years later, he went up to Trinity College, Cambridge, and while there he helped to 'work his passage' by coaching men in Greek. He was one of the band of eager students who gathered round F. M. Balfour and Michael Foster, then laying the foundations of the modern Cambridge school of biology. He took a first class in Part II of the Natural Sciences Tripos and for a year demonstrated in Michael Foster's laboratory.

In 1884, at the early age of twenty-four, D'Arcy Thompson was appointed professor of biology (later altered to natural history) in the recently founded University College in Dundee. When, in 1897, after embittered disputes and litigation, the College was made one of the constituent colleges of the University of St. Andrews, he became a member of the Senate, and, twenty years later, on the retirement of Prof. W. C. M'Intosh, he was translated to the senior chair in the United College at St. Andrews. His tenure of the chairs at Dundee and St. Andrews extended to sixty-four years, a record that, under modern conditions, will not be repeated.

Some dates alone must stand for the stages of his scientific career. In 1896 and again in 1897 he went to the Bering Sea as member of the British – American inquiry into the fur-seal fishery, and in the latter year he was British representative on the international conference on the subject at Washington. For these services he received the C.B. in 1898. In the latter year he was appointed to the Fishery Board for Scotland and remained a member until the abolition of the Board in 1939. He was one of the British representatives on the International Council for the Study of the Sea from its beginning in 1902, and he edited and contributed largely to the Scottish section of its reports. He also wrote many papers on fishery statistics and oceanography in the "Scientific Investigations" of the Scottish Fishery Board from 1913 until 1931.

When D'Arcy Thompson went to Dundee, he at once began to assemble a teaching collection for the illustration of his lectures, which were never bound by the fetters of the 'type system'. At that time the Dundee whaling industry had not quite come to an end, and several of the whaling skippers were persuaded to bring back to him a large amount of vertebrate and invertebrate material, much of it of great value and interest. With the addition of collections obtained on his visits to the Bering Sea he got together a museum of arctic zoology which at the time had no equal in Britain.

It was in 1908 that a short paper in *Nature* on "The Shapes of Eggs and the Causes which Determine Them" gave the first published intimation of a line of inquiry that had long engaged his thought and on which he had accumulated masses of notes. In 1917 he published his book "On Growth and Form". This remarkable work at once attracted attention, not so much for the novel ideas it contained (though these were many) as for the mass of illustrative material it brought together from writers ancient and modern, many of whom the average zoologist had never heard of. The perfect pellucidity of its writing and the way in which it made problems, essentially mathematical, comprehensible to the non-mathematician, attracted many readers. It speedily went out of print and had the distinction, rare for a scientific book, of appearing in second-hand book catalogues at ten times its published price. Its central theme is the inquiry how far the form and structure of living things can be interpreted in terms of the physical forces acting within the life-time of the individual organism. It appeared at a time when increasing attention was being paid to this 'causal morphology' as distinguished from the 'historical morphology' which was the almost exclusive study of the period that preceded it. Sir D'Arcy was much too wise and experienced a naturalist to imagine that such an interpretation would take us all the way, but some of his followers were less cautious. In his second, much enlarged, edition, published in 1942, he has to add a warning; in the end, he says, "the twofold problem of accumulated inheritance, and of perfect structural adaptation, confronts us once again and passes all our understanding".

A striking testimony to the influence of this book on a younger generation of biologists is given by the volume of "Essays on Growth and Form presented to D'Arcy Wentworth Thompson", edited by Prof. W. E. Le Gros Clark and Prof. P. B. Medawar, published by the Clarendon Press in 1945.

This is not the place, even if I had the knowledge necessary, to assess the value of Sir D'Arcy's studies on the natural history of the ancient world. His "Glossary of Greek Birds" appeared in 1895, and a second edition in 1942: his translation of Aristotle's "Historia Animalium" was published in 1910 and his "Glossary of Greek Fishes" in 1945; the repute of these and his numerous shorter papers on classical subjects may be gathered from the fact that he was president of the Classical Association in 1929 and of the Scottish Classical Association in 1935. The list of his honorary degrees, honorary memberships, lectureships, medals and so forth is far too lengthy to be given here, ranging, as it does, from Aberdeen to Johannesburg and from Boston to Delhi. He was elected to the Royal Society in 1916, was a vice-president during 1931–33, and awarded the Darwin Medal in 1946. He was president of the Royal Society of Edinburgh during 1934–39. He flew to India at the end of 1946 as one of the four delegates sent by the Royal Society to the meeting of the Indian Science Congress in Delhi; but the strain of the journey was too much for his years and he never completely recovered his health. He was knighted in 1937.

Sir D'Arcy was a man of very striking presence with a resonant and beautifully modulated voice which made his lectures and addresses a pleasure to listen to.

Lady Thompson and her three daughters are assured of the sympathy of his innumerable pupils and friends in all quarters of the globe.

W. T. CALMAN

SIR D'ARCY THOMPSON was not the only man of science in his generation who 'kept up his classics' and pursued them in connexion with his professional work. Other biologists were Sir Edward Poulton and Dr. F. A. Dixey. But Sir D'Arcy's studies were on an ampler scale. Both his "Glossary of Greek Birds", published forty years ago and recently in a well-groomed second edition, and his "Glossary of Greek Fishes", reviewed in these columns only a few months since, are the classical books of reference in their subject, and illustrate his wide range of literary scholarship as well as his tireless industry. They are supported by a rich flow of smaller articles and notes covering a wider field, and by invaluable services as a member of the staff of the revised "Liddell and Scott". Two examples will illustrate his range and versatility. He was the first to make geometrical sense of Herodotus' description of the Great Pyramid, and to show how its form was related to the processes of its construction. And his knowledge was at his instant disposal. I referred to him some years ago, at the request of a distinguished surgeon, the Homeric description of the death-struggle of Nestor's chariot horse, struck through the forehead by an arrow. The reply came by return of post—"written in the laboratory": the arrow had grazed the cerebellum, and the convulsive movements of the limbs, causing the horse to roll over and over, were precisely what were to be expected. He had seen the same death-struggle in a rabbit, and dissected out the fatal pellet from an identical wound.

On the low shore of Lake Superior, the train nearly left behind three of the party, plucking wild raspberries. My snapshot bears the legend, "Berries and beavers".

JOHN L. MYRES

Prof. B. E. Livingston

WITH the passing of Burton Edward Livingston early this year, plant physiology in the United States has lost a distinguished figure. Himself an indefatigable investigator, he devoted much time and energy to the stimulation of scientific research and the promotion of co-operation and intercourse among his fellow men of science. From 1920 onwards he was a member of the executive of the American Association for the Advancement of Science, for fourteen years as secretary, and became its chairman in 1941. He served on the National Research Council. Among many other activities he took a prominent part in the foundation, in 1924, of the American Society of Plant Physiologists; he was elected one of its first vice-presidents and was the first to be elected life member under the Charles Reid Barnes Foundation. The esteem in which the Society held him as an investigator was very appropriately indicated when in 1946 it conferred on him the Stephen Hales Award, since his chosen field was the quantitative study of the water relations of plants, in which Stephen Hales was the pioneer.

Livingston's interest in this aspect of plant physiology was established at the very beginning of his career. Having graduated at Michigan in 1898, he went to Chicago as fellow and assistant in plant physiology. Five years later, at the age of twenty-eight, he published his book on "The Role of Diffusion and Osmotic Pressure in Plants". A visit in the summer of 1904 to the recently established Desert Laboratory of the Carnegie Institution at Tucson, Arizona, provided the material for his "Relation of Desert Plants to Soil Moisture and to Evaporation" (1906), in which the scheme of his later work was foreshadowed. A short period with the U.S. Bureau of Soils and three years at Tucson preceded his appointment in 1909 to the chair of plant physiology at the Johns Hopkins University, which he occupied until his retirement in 1940.

Livingston's contributions were marked by comprehensive grasp and clarity of analysis. He emphasized from the first the dynamic aspect of the relations between plants and their environment. His approach was primarily that of a physiological ecologist: the influence of Schimper is evident in his early work. He was impressed by the complexity of the environment and the interaction of factors in their influence upon the plant. He held the separate measurement of those factors to be insufficient in the study of plant distribution and adaptation ; so he sought methods of assessing their integrated effects. He introduced the dynamic concepts of the water-supplying power of the soil and the evaporating power of the air. His porous porcelain atmometers (evaporimeters) with standardized spherical bulbs have been very widely used. He sought to measure the water-supplying power of the soil by inserting osmometers in it. Although he may have over-estimated the mobility of capillary water, his experimental approach was sound and stimulating. Connected with these investigations was his introduction of the auto-irrigator, a porous pot supplying water to the soil at a predetermined capillary potential.

As physiologist he sought to express the water relations of plants in terms of quantitative physical laws, as affected by variations of water content and internal resistances as well as by external factors. As ecologist he aimed at correlating the distribution of vegetation with the quantitative data and at giving precision to otherwise vaguely defined distinctions. This is the keynote of "The Distribution of Vegetation in the United States as related to Climatic Conditions", which he published with Forrest Shreve in 1921.

The long series of papers which emanated from Baltimore during the thirty years of his tenure are ample proof of the stimulus of his leadership.

D. THODAY

NEWS and VIEWS

Egyptology in the University of Liverpool: Prof. A. M. Blackman

WITH the retirement, on reaching the age-limit, of Dr. Aylward M. Blackman from the Brunner chair of Egyptology, which he has held since 1934, the University of Liverpool loses a fruitful teacher and a valued contributor to a number of branches of ancient Egyptian studies. Born at Norwich in 1883, and a keen student of Egyptology from the age of sixteen, Dr. Blackman was educated first privately, then at St. Paul's School, London, and Queen's College, Oxford, where in 1906 he took a first class in Oriental Studies. During 1906–14 and 1920–21 he took part in or directed excavations and recording in Egypt (Oxyrhynchus, Abydos, Meir, El-Amarnah) and the Sudan (Survey of Nubia, Buhen, Faras, Sesebi). During 1912–18 he was Laycock Student of Egyptology of Worcester College, Oxford. Since 1935 he has been joint editor, with Prof. J. P. Droop, of the *Annals of Archæology and Anthropology*, and during 1922–35 was a member of the Council of the Royal Asiatic Society. From 1936 on he has been special lecturer in Egyptology in the University of Manchester. His publications have been numerous ; chief among them are four volumes on "The Rock Tombs of Meir" (1914–24), with about eighty plates drawn by himself, and volumes on the Lower Nubian temples of Dendûr, Derr and Bîgeh. Other works deal especially with Egyptian myth and ritual. He has done much to present Ancient Egypt to a wide public. All Egyptologists will hope that it will be possible for Dr. Blackman to continue his Egyptological researches for many years to come.

Mr. H. W. Fairman

DR. BLACKMAN's successor is Mr. Herbert Walter Fairman, who has been an active worker in the field since 1929 (war-service excepted). Mr. Fairman was born at Clare, Suffolk, in 1907; but he spent his early years in Egypt, where his father was a missionary. He was educated at Goudhurst School, Kent, going eventually to the University of Liverpool, where he studied Egyptology under the late Prof. Peet. For the next ten years he took part in excavations conducted in Egypt and the Sudan by the Egypt Exploration Society—at the cemetery of the Buchis bulls at Armant, 1929-31 ; at El-Amarnah, 1930–36 ; at Sesebi, 1936–38 ; at Amarah West, 1938–39 and 1947–48. In 1937 he became the Society's field director. At Armant and El-Amarnah he was primarily responsible for the publication of the inscriptions. The need to interpret the difficult late writing of the Ptolemaic and Roman inscriptions relating to the Buchis bulls led him to specialize in the texts of those periods, and he has become one of the very few contemporary authorities on them. During 1940–47 he was engaged in war-time duties at the British Embassy, Cairo, and while there he gave many lectures on Ancient Egypt to troops in his spare time. It is hoped that his teaching duties at Liverpool will leave him opportunities to continue his researches into the texts of the latest periods, which contain many remarkable matters not generally known even to Egyptologists.

Chemistry at the University College of North Wales, Bangor: Dr. Stanley Peat, F.R.S.

DR. STANLEY PEAT, reader in organic chemistry in the University of Birmingham, has been elected to the chair of chemistry at the University College of North Wales, Bangor, University of Wales, in succession to Prof. E. D. Hughes, who is going to University College, London (*Nature*, April 3, p. 511). Dr. Peat had a distinguished career as a student of King's College, Newcastle, University of Durham, which he entered with a State Scholarship and the Earl Grey Scholarship in 1921. He graduated with first-class honours in the University of Durham in 1924 and was awarded the Saville Shaw and the Freire-Marreco Medals on graduation. He there joined the research school of Sir Norman Haworth, and eventually followed him to the University of Birmingham. His first joint publication in 1926 was on a revision of the structural formula of glucose. After obtaining his doctorate he was appointed lecturer in the Department of Physiology in the Medical School of Birmingham under Prof. I. de Burgh Daly, and published several papers in physiological journals on histamine. In 1934 he transferred to the teaching staff of the Department of Chemistry at Birmingham and engaged in constitutional studies of the polysaccharides. Outstanding among his publications are : his proof by synthesis of the configuration of glucosamine, the constitution of maltose, the studies of the mechanism of inversion of configuration in the sugar group, and especially the study of the enzyme systems responsible for the synthesis and degradation of starch. This latter work has led to the isolation of the Q-enzyme which is responsible for the biosynthesis in the presence of phosphorylase of the major component of starch, amylopectin. He has shown, moreover, that the Q-enzyme from potato converts the amylose to amylopectin, and he has devised an elegant method for the separation of the two components of starch. His more recent work has been on the photochemical degradation of carbohydrates, which has opened up what is practically a new field of investigation, the main features of which appear to be an indication of the reversal of the photosynthesis of starch. He has served as the English editor of the international publication "Advances in Carbohydrate Chemistry".

Royal Society of Medicine : Sir Henry Dale, O.M., G.B.E., F.R.S.

THE Royal Society of Medicine elects its president annually, and he may be re-elected for a second year. The practice has been to offer the presidency in turn to a physician, a surgeon and a specialist. This year it has been the turn of the specialist, and Sir Henry Dale, the distinguished former director of the National Institute for Medical Research, and president during 1940–45 of the Royal Society, has been elected; this is the first time that a man whose chief claim to distinction has been in the field of pure science has been elected. The Royal Society of Medicine, like so many learned bodies, originated from meetings of a group of young men in London eager to discuss their work. It was founded in 1805, and its chief purpose has always been "the cultivation and promotion of physic and surgery, and all the branches of science connected with them". It received a Royal Charter in 1834. During its first century, the Society was mainly active in London, but in 1907 a number of medical societies joined forces with the Royal Medico-Chirurgical Society of London, as it was then called, to form the present well-established body, and a Supplemental Charter was given it. The Society now has some 9,000 fellows, of whom more than 1,200 are overseas ; all nationalities are represented. The Society functions through twenty-four specialized sections, which hold some two hundred meetings between them every year. Members of the Society are justly proud of its library, which has a record of great activity. Apart from the provision of books, it has been able, through a grant from the Rockefeller Foundation, to give substantial assistance in the restoration of medical libraries which had suffered through the War, by providing microfilm copies of journals now out of print.

Air Photography and Archæology

THE importance of air photography for the archæologist cannot be exaggerated. Not only does it permit accurate plotting of the visible monuments of an area to be made when detailed maps of the district are inaccurate or non-existent, but further it frequently indicates where ancient monuments now disappeared had once stood. Let us suppose a building, say, a Roman villa, once occupied an area of ground. Where the foundations had been dug the soil would have been disturbed, and, though perhaps nothing is visible now above ground, below the soil much brickwork, etc., would still occur. Corn or other crops on the field where the villa had been would grow somewhat differently as to height and density where the foundations lie, and would thus mark out as it were on a plan where they were. On the ground nothing can be seen ; from the air the whole is clearly set out. Messrs. Kodak are to be congratulated on the exhibition of such photographs which has been arranged at their premises in Regent Street, London, and is open to the public until July 21. An excellent explanatory pamphlet by Dr. J. K. St. Joseph, illustrated by a number of actual air photographs, has been issued. There are also maps showing where the various sites appearing in the exhibition occur. Such well-known localities as Stonehenge and Avebury have been included.

Biological Research Institute, Tihany

THE Director-General of Unesco, Dr. Julian Huxley, during his four-day visit to Hungary as guest of the Hungarian Government, spent June 13 at the Biological Research Institute at Tihany, Lake Balaton (see *Nature*, **158**, 456 ; 1946). Dr. Huxley was interested in the success of the efforts, made immediately after the cessation of fighting and during the inflation, which have resulted in a Research Institute capable of publishing, each year since 1945, the Archiva Biologica Hungarica, containing some thirty-five papers in congress languages (mostly in English). He approved the idea which had here been followed of assembling in one Institute the greatest possible variety of biological disciplines, and showed himself keenly aware of the many advantages of such a system, especially in small countries. Dr. Huxley was interested to hear that several research workers were to go to the Institute for a period. Two places are reserved for invited Russian biologists ; two English men of science are going for the summer and autumn and two Finnish biologists are also expected.

Exchange of War-time Periodicals with Germany

EFFORTS are still being made by the Foreign Office to make possible the exchange in bulk of periodicals issued during the Second World War by British learned societies, universities, and other institutions with those published by similar bodies in Germany. These efforts are more likely to be effective if information concerning the numbers of publications involved can be supplied. Interested librarians are accordingly asked to notify either the Director of the Association of Special Libraries and Information Bureaux, 52 Bloomsbury Street, London, W.C.1, or the Secretary of the Library Association, if they have not already done so : (*a*) of the total number of volumes or parts of periodicals issued during the War and held by them for exchange with German institutions, and (*b*) of the numbers which they should receive in return, indicating clearly whether it is known that these German publications are available for exchange purposes. The returns should be headed : "German exchange". It should be understood that the information asked for relates only to the war-time accumulation of periodicals for exchange. Future exchanges must be arranged by institutions in the two countries privately.

Benjamin Franklin as Printer and Publisher

VOL. 92, No. 2 of the *Proceedings of the American Philosophical Society* (1948) is devoted to studies of historical documents in the library of the Society at Philadelphia. Chief among these is a paper by W. E. Lingelbach on new source material regarding Benjamin Franklin's activities as printer and publisher both during the first half of his life and in his later years. Much of the material relates to his interests in Philadelphia during 1728–66, the most interesting being concerned with his printing activities in Passy. This latter includes a unique collection of more than four hundred brass stencils, apparently used by Franklin in the study and designing of type, as well as inventories of fonts cast at Passy and of type and other printing materials purchased from the leading English, French and possibly Dutch type-founders. Other articles in this number include Prof. G. Chinard's study of Franklin as negotiator, December 1777, Prof. P. A. W. Wallace's appreciation of H. E. Muhlenberg's work as botanist, Prof. T. D. Cope's note "Collecting Some Material about Charles Mason and Jeremiah Dixon", the astronomers and geodetic surveyors, and Prof. I. J. Cox's account of the Freeman Red River Expedition of 1806.

Establishment of Hardwoods in Britain

MANY will welcome the small Forestry Commission pamphlet No. 2 of the Forest Operations Series (who invents these cumbersome titles ?) on the "Establishment of Hardwoods" (London: H.M. Stationery Office. 9*d*. net). The small area of 35,000 acres only was afforested or replanted in Britain with various hardwoods during the first twenty-five years of the Forestry Commission. A bulletin recording the information so far gathered on the subject of sowing and planting to form the new plantations was in the press just before the outbreak of war, but was destroyed during the bombing of London. The present one has been prepared from a report of Mr. A. H. Popert, acting conservator in the south-west of England, as a result of a tour of the Commission's hardwood plantations. It is perfectly well known that the raising and tending of young hardwood crops, save in exceptionally favourable circumstances of habitat, are more difficult and call for more experience than is required for conifers. The bulletin gives notes on the chief timber species—oak, beech, ash, sycamore, sweet chestnut, birch and alder. It also deals with the treatment of coppice woods and devastated woodlands ; on these latter subjects, some who have lived with and studied coppice areas may differ from the views contained in the paper. As a result of war-time and present-day fellings of the fine hardwoods, it is noted that the "Establishment of broad-leaved trees is likely to assume increasing importance in British Forestry".

"Not poppy, nor mandragora . . ."

"An Index of Modern Remedies", by William Mair, has, since it was first published in 1941, been useful to the medical and pharmaceutical professions, to whom alone it is issued. The appearance of a new edition (Fourth Series, 1948. *Scottish Chemist*, 240 Albert Drive, Pollokshields, Glasgow, S.1 ; and from Messrs. H. K. Lewis and Co., Ltd., 136 Gower Street, London. 3*s*.) will therefore be welcomed. This new edition contains, as well as a few recently coined names of remedies, a valuable article on the 1948 edition of the British Pharmacopœia, with lists of the 250 new admissions to this publication and of the omissions from it. There is also a useful list of costly and essential drugs now exempted from the purchase tax. As Mr. Mair rightly says in his introductory note, no physician or pharmacist can nowadays be familiar with the names, composition and action of all the pharmaceutical preparations on the market, and he has set out to give this information in a handy and well-indexed form. He also gives, by means of a key, the names and addresses of manufacturing chemists and the preparations which they make. Using this book, one realizes how many names some drugs nowadays have, the changes these names have undergone and how different they may be in different countries. Pentothal, for example, is now thiopentone soluble B.P. and U.S.P., and aminacrine hydrochloride B.P. used to be, and no doubt still is in some quarters, acramine, monacrin or acramine yellow. The maze of names given to the antimalarial drugs and to the sulphonamides and their derivatives are here sorted out, and a short supplement lists special injection solutions for parenteral therapy. More than half the book is devoted to a classification of various remedies according to their mode of action. In this section the statement that phenothiazine is an anthelmintic of low toxicity needs modification. As Prof. J. H. Gaddum says in his foreword, this book is a valuable guide and provides information not easily obtained elsewhere, even in more expensive books.

Pfund Issue of the *Journal of the Optical Society of America*

THE October 1947 issue of the *Journal of the Optical Society of America* is the largest issue of the journal ever to be published and was specially called the "Pfund Issue". It consists of articles written by Prof. A. H. Pfund's former students and colleagues and is a tribute to him on his retirement from active teaching at the Johns Hopkins University. An advance copy of this issue, together with a 'scrap-book' containing the letters which accompanied the manuscripts of the articles when they were submitted for publication, was presented to Prof. Pfund at the dinner held during the thirty-second annual meeting of the Society in October last. A photograph of Prof. Pfund is on the opening page, and the first of the twenty-three articles in the issue is by Prof. R. W. Wood, who writes on "The Use of Echelette Gratings in High Orders". Two of the articles are actually by Prof. Pfund himself and co-workers, but he was unaware that his colleagues had submitted the papers for a special issue of the *Journal*. They deal with selective infra-red gas analysers and with optical scattering by dielectric powders. The other articles include: a historical note on the rate of a moving clock by H. E. Ives ; a spark light-source of short duration by J. W. Beams and others ; an optical study of acoustic fields near diffraction edges by J. C. Hubbard and others ; and practical methods of making and using multilayer filters by Mary Banning.

Hot-wire Vacuum Switches

SUNVIC CONTROLS, LTD., 10 Essex Street, Strand, London, W.C.2, manufacturers of vacuum switches, temperature control and associated equipment, have recently issued a 16-page illustrated pamphlet describing their hot-wire vacuum switches. The Sunvic hot-wire vacuum switch is contained within an evacuated glass tube not much larger than an ordinary radio valve, and is a non-arcing electric relay, the operation of which depends on the fact that when an electric current is interrupted by the separation of two surfaces in a vacuum no arc is formed. The movement necessary to close or open the switch is quite small and is provided by the thermal expansion of a special steel wire through which a control current of some 25–60 m.amp. is passed. The switch contacts are tungsten and are normally held apart against a compressed spring, which is released by the expansion of the hot wire. The operating characteristics of many different forms of hot-wire vacuum switches with various time delays, closing currents and current-carrying capacities are listed, and twelve different standard circuit and wiring diagrams are shown. The hot-wire vacuum switch is capable, in various sizes, of handling up to 10 kW. at 440 volts, and is suitable for controlling alternating or direct currents up to 30 amp. and voltages from 10 to 600.

J. J. Thomson on "Cathode Rays"

THE text of J. J. Thomson's historic Royal Institution lecture of April 30, 1897, on "Cathode Rays", has been reproduced in full in the November–December issue of the *American Journal of Physics* as the contribution of the American Association of Physics Teachers to the Electron Jubilee celebrations (see also *Nature*, **160**, 776; 1947). It will be recalled that it was in this lecture that J. J. Thomson, after discussing Lenard's, Perrin's and some of his own experiments on the charges carried by cathode rays, concluded that "the size of the carriers [of electrical charge] must be small compared with the dimensions of ordinary atoms and molecules". Further, that from his experiments on the deflexion of cathode rays, he was able to deduce a value for m/e which, quoting from the final words of the lecture, was "of the same order as the value 10^{-7} deduced by Zeeman from his experiments on the effect of a magnetic field on the period of the sodium atom".

Italian Polar Research Institute

A NEW polar institute, Istituto Geografico Polare, has been formed in Italy under the directorship of Dr. S. Zavatti. The *Polar Record* for January–July announces that the aims of the institute are: (1) to widen knowledge of all polar areas; (2) to encourage interest in polar affairs in Italy and to publish Italian contributions to polar knowledge; (3) to form a polar library; (4) to publish a monthly periodical, *Il Polo*; and (5) to publish maps of scientific value on polar regions and a series of "Polar Classics". The first number of *Il Polo* came out in February 1946. The address of the new institute is Istituto Geografico Polare, Porto Potenza Picena, Macerata.

Pathogenicity of *Aspergillus nidulans*

THERE are numerous reports in medical literature of infection of man and other animals by species of the fungal genus *Aspergillus*. Pathogenicity of *A. fumigatus* is comparatively well known, and *A. nidulans* has occurred in circumstances which seemed to implicate it as a cause of disease. Dr. Charles H. Drake has studied the latter species in a recent paper (*Mycopathologia*, 4, Fasc. 2, pp. 103; 1948). He finds that the fungus is pathogenic to rabbits, causing initially a purulent inflammation with abscess formation. Subsequent injections may give rise directly to tubercles, in which the fungus changes morphologically to give actinomycetoid granules. Cell-sap of *A. nidulans* is not toxic to rabbits, but stimulates the formation of precipitins. This species does not appear to be pathogenic to guinea pigs, which fact might explain some earlier uncertainty about its disease-producing character.

Land-mine Detectors

FOLLOWING a request, received early in 1940, by the Scientific Advisory Committee of G.H.Q. Middle East for work to be undertaken on the design and construction of land-mine detectors, Dr. Lawrence Balls, then chairman of the Committee, together with Mr. J. H. Cole, and with the assistance of military personnel, produced, and tried out in actual operations, several successful models. In an article entitled "Land-mine Detectors designed at Giza", which Dr. Balls contributes to the June number of *Reme*, the journal of the Corps of Royal Electrical and Mechanical Engineers, details are given of the construction, performance and characteristic features of these land-mine detectors. They were of various sizes, the large models suitable for road clearance, and the smallest for surgical applications, such as shrapnel detection in wounds. The Mark IV design was first used, but was superseded by an original design due to Dr. Balls, consisting of twin search-coils, thus giving double sensitivity. Coils of about 12-in. diameter were found convenient for ordinary field detectors, and of about ⅜-in. for surgical use. Operating on the heterodyne principle, a frequency of one megacycle per second proved most useful, with a frequency ratio of two-thirds to produce the audio-frequency beat-note. Segmented screening, twin oscillators, and a low-loss chassis were the three main characteristics of the 'twin' design. The earthed screen surrounding a search-coil was cut, usually, into twelve segments, each segment being separately connected by a thin wire to a central earth on the chassis. The two identical search-coils, mounted together in the same plane, were inductances of separate oscillatory circuits, driven from a single twin-triode valve. Passage of the coils over a metal object caused the beat-note, somewhat lower than middle C, to be altered downward by one coil and upward by the other, thus causing the headphone note to change suddenly from a progressively lowering growl to a falling high shriek as the object passed from one coil to the other. The weight of a one-man detector is naturally a matter of practical importance, and a prototype, of which two copies were flown to Britain in 1943 but too late to be considered for production, and which was made of wax-boiled wood though designed for production in plastics, weighed only 14½ lb., of which the batteries accounted for more than half.

Mathematical Tables for Science and Industry

THE lack of the relevant mathematical tables for investigations in the physical, chemical and engineering sciences, in mathematics and in industry may well delay progress, and steps are being taken to meet the difficulty. Much work in this field has been done, and tables of a fundamental nature have been produced by the British Association through its Mathematical Tables Committee. These activities have now been transferred to the Royal Society on the invitation of the British Association, and a special Royal Society Mathematical Tables Committee has been established to continue and extend the earlier work. The Committee would be glad to receive suggestions from industrial research groups, from individual investigators and from Service departments relating to existing needs in their special fields. Requests for assistance may be met either by advice as to the most economical way of producing the desired tables, or by an undertaking to produce the tables under the auspices of the Royal Society, or, in exceptional cases, by a grant towards the cost of tabulation or to make possible the publication of important tables which may exist only in manuscript. In the first instance inquiries should be addressed to the Assistant Secretary, Royal Society, Burlington House, London, W.1.

Congress of the Universities of the Commonwealth

THE sixth Congress of Universities of the Commonwealth will be held at Oxford during July 19–23. Some three hundred delegates are expected to attend, and observers have been appointed by Unesco, the United States and various learned institutions. Among the topics to be discussed are: relations of the State and the universities; inter-university relations; a critical review, from the points of view of a historian, a philosopher and a sociologist, of the structural and moral changes produced in modern society by scientific and technological advance; the balance of research and teaching in universities; general plan for colonial higher education; extension of the university secondment scheme. The Congress is being preceded by a private conference, held at Bristol during the past week, of executive heads of universities.

Fifth Commonwealth Entomological Conference

PRIOR to the War, Imperial Entomological Conferences were held in London at five-yearly intervals, but because of the War it is now thirteen years since the last one assembled. The Fifth Commonwealth Entomological Conference, to be held in London during July 22–30, will be attended by forty-two delegates, eleven representing the United Kingdom, nine the Dominions and twenty-two the Colonies, Protectorates, Dependencies and Southern Rhodesia. All meetings, with the exception of certain business meetings to be held on July 22 and 30, will be open to the public. The Conference has been convened by the Executive Council of the Commonwealth Agricultural Bureaux and organised by the Commonwealth Institute of Entomology, which is one of the constituent bodies of the former organisation. With the exception of one meeting to discuss plant quarantine, all other topics selected for discussion have been chosen because they relate to some branch of applied entomology in which outstanding developments have occurred since the last Conference which met in 1935; they include insecticides, biological control, estimation of insect populations in the field, control of insects in stored products, tsetse control, locusts and grasshoppers. Further particulars can be obtained from the director of the Commonwealth Institute of Entomology, British Museum (Natural History), Cromwell Road, London, S.W.7.

Conference on Biology and Civil Engineering

A Conference on Biology and Civil Engineering will be held at the Institution of Civil Engineers during September 21–23. This conference is intended primarily for members of the Institution and others engaged in civil engineering work where the problem of the effect of vegetation is an important factor. Papers will deal with research and other work carried out not only in Great Britain, but also in New Zealand, South Africa, Holland and the British West Indies. Among the topics for discussion are: causes, effect and prevention of soil erosion; effect of vegetation on drainage and floods; effect of vegetation in stabilizing artificial slopes; use of vegetation to stabilize sand dunes; effect of vegetation on the settlement of roads and structures; algal growth and engineering design. All meetings will be held at the Institution of Civil Engineers, from which further particulars can be obtained.

University of London: Appointments

THE following appointments in the University of London have been announced: Dr. J. L. D'Silva, reader in physiology at St. Bartholomew's Hospital Medical College, to the University chair of physiology tenable at the London Hospital Medical College, as from October 1; Mr. C. H. Gray, lecturer in biochemistry at King's College Hospital Medical School, to the University chair of chemical pathology tenable at the School, as from April 1; Dr. H. A. Magnus, director of the Pathology Department and morbid anatomist to King's College Hospital and to the Medical School, to the University chair of morbid anatomy tenable at King's College Hospital Medical School, as from April 1.

University of Sheffield

MR. S. C. GOODWIN has provided £600 per annum, under covenant for seven years, to provide, through the Cutlers' Company, a fellowship in the University of Sheffield which will be known as the Goodwin Fellowship for postgraduate work in engineering or metallurgy, to be offered in each of the next seven years. Each fellowship will be awarded by the Cutlers' Company, on the recommendation of the Senate of the University. The value of each fellowship will be £300 a year, tenable for two years.

The Council of the University of Sheffield has made the following appointments: C. R. K. Blundell, lecturer in geology; T. Summerfield King, lecturer in anatomy; A. A. Carlyle, lecturer in physiology; John Fiddes, assistant lecturer in physics; Gilbert Y. Kennedy, research worker in the Department of Pathology under the auspices of the British Empire Cancer Campaign.

University of Aberdeen

THE honorary degree of doctor of laws has been conferred by the University of Aberdeen on the following, among others: Dr. G. A. Currie, vice-chancellor of the University of Western Australia; Lord Dudley Gordon, president of the Institution of Mechanical Engineers; and Sir John Boyd Orr, director-general, United Nations Food and Agriculture Organisation.

The degree of doctor of philosophy has been conferred on the following, the title of the thesis presented appearing in brackets: C. H. Gimingham ("Life-Form in Plants and the Structure of Plant Communities"); N. Grassie ("A Study of the Thermal Degradation of Polymethyl-methacrylate"); H. G. M. Hardie ("Studies on Phosphate Fixation in Soil"); R. J. Hay ("The Kinetics of the Gas Phase Polymerisation of some Vinyl Derivatives"); Shih-Chen Liang ("The Study of Wood Anatomy within the Genus *Larix* and the Influence of Internal and External Factors Thereon"); Muriel Mackay ("Some Aspects of the Photo-polymerisation of Methyl-methacrylate"); A. McLaren ("Certain Aspects of Free-radical-initiated Polymerisations"); C. R. Masson ("Osmometry of High Polymer Solutions"); Gargestwari Narayana Subba Rao ("Physico-chemical Investigations on the Muscle Proteins of some Commercial Species of Fish caught in North-East Scottish Waters"); J. C. Robb ("The Kinetics of the Interaction of Atomic Hydrogen with Olefines"); J. D. Stewart ("A Comprehensive Survey of the Mathematical Education of Engineers"); R. B. Whyte ("The Photosensitisation of Polymerisation in the Liquid Phase"); G. W. Youngson ("The Synthesis of Branched-chain Polymers").

Royal Commission for the Exhibition of 1851: Awards

The Commissioners for the Exhibition of 1851 have announced the award of Overseas Science Research Scholarships for 1948 to the following (the subject and place of research are given in brackets). On the recommendation of the University of Toronto: A. C. Hollis-Hallett (physics, University of Cambridge). On the recommendation of the University of Melbourne: N. N. Greenwood (physical chemistry, University of Cambridge). On the recommendation of the University of Sydney: Miss D. C. Davison (plant biochemistry, University of Cambridge); and P. B. Treacy (nuclear physics, University of Cambridge). On the recommendation of the University of New Zealand: C. F. Coleman (nuclear physics, University of Cambridge or Birmingham); D. S. Coombs (geology, University of Cambridge); and E. O. Hall (physics, University of Cambridge). On the recommendation of the University of Delhi: R. P. Bambah (mathematics, University of Cambridge or London). On the recommendation of the University of the Punjab: Miss M. Mehtab (cytology, University of Edinburgh).

Institution of Electrical Engineers: Officers for 1948–49

The following officers and new members of Council of the Institution of Electrical Engineers have been elected to take office on September 30: *President:* Mr. T. Graeme N. Haldane; *Vice-Presidents:* Mr. A. J. Gill, Col. B. H. Leeson; *Honorary Treasurer:* Mr. E. Leete; *New Members of Council:* Mr. S. E. Goodall, Mr. H. W. Grimmitt, Mr. J. Hall, Dr. W. G. Radley, Dr. H. W. H. Warren, Mr. E. L. E. Wheatcroft, Mr. M. W. Humphrey Davies, Mr. A. V. Milton.

Douglas Lea Memorial Lecture

As a memorial to the late Dr. Douglas Edward Lea, the Hospital Physicists Association has decided to found a memorial lecture, to be given biennially during one of the meetings of the Association, by a worker of distinction in the field to which Dr. Lea had made many outstanding contributions, namely, the actions of radiation on living cells. The lectures will be open to the public, and the Association has set up a Trust Fund to cover the expenses of these lectures in perpetuity. Any income in excess of that required to meet the expenses of the lectures will be devoted to scientific research or publication. Friends of the late Dr. D. E. Lea who may wish to contribute to this Fund are asked to communicate in the first place with Mr. J. W. Boag, Medical Research Council, Hammersmith Hospital, London, W.12, who will notify them of the way in which contributions should be made.

Announcements

The King in Council has approved of a charter granting full university status to the University College of Nottingham. Lord Trent, president of the College, will be the first chancellor; Mr. B. L. Hallward, head master of Clifton College, will be vice-chancellor.

The Hungarian Academy of Science has established an Eötvös Medal in commemoration of the hundredth anniversary of the birth of the famous Hungarian physicist, Loránd Eötvös. The first Eötvös Medal has been awarded to Prof. J. Barnóthy and Dr. M. Forró for their outstanding achievements in the realm of cosmic radiation.

The James Scott Prize for 1948 of the Royal Society of Edinburgh was presented to Prof. Herbert Dingle at the ordinary meeting of the Society held on July 5, 1948, at which, in terms of the Prize, Prof. Dingle delivered an address on "The Nature of Scientific Philosophy". The Neill Prize (1945–47) was presented *in absentia* to Dr. Robert Broom, for his contributions to our knowledge of the fossil vertebrates of the Karroo Beds of South Africa.

Dr. S. L. Hora, director of the Zoological Survey of India, has been appointed an honorary member of " 's Lands Plantentuin" by the staff of the scientific institutes of south-east Asia constituting this body. The letter from Dr. L. G. M. Bass Becking, director of the Botanic Gardens, Buitenzorg, giving this announcement, makes appreciative reference to Dr. Hora's contributions to tropical zoology, to the spirit of co-operation and friendship he is always able to convey to colleagues abroad, and to the need for scientific men in south-east Asia to join forces in promoting reconstruction measures.

The managers of the Royal Institution have made the first appointment to the Science Research Scholarships of the Institution offered to candidates from overseas universities. One of these scholarships is to be awarded each year on the advice and recommendation of the Science Scholarships Committee of the Royal Commission for the Exhibition of 1851, and the award for 1948 has been made to Miss Philippa Marion Glasgow; Miss Glasgow is a physical chemist, and holds the degree of M.Sc. of the University of New Zealand.

The following have been elected to Beit Fellowships for Scientific Research of the value of £400 per annum each, tenable at the Imperial College of Science and Technology: P. W. M. Jacobs, for research in physical chemistry under the direction of Prof. H. V. A. Briscoe; M. J. M. Bernal, for research in applied physical chemistry under the direction of Sir Alfred Egerton.

The Flatford Mill Field Centre of the Council for the Promotion of Field Studies, 10 Exhibition Road, London, S.W.7, will be formally opened by the chairman of the Carnegie United Kingdom Trust, Mr. E. Salter Davies, on July 23.

We have received a copy of No. 1 of Vol. 2 of *Quarterly Reviews*, published by the Chemical Society (price to non-fellows, 8*s*. per number or 25*s*. per annum). It contains, in 91 pages, articles by H. N. Wilson and J. G. M. Bremner on "Disproportionation in Inorganic Compounds", by D. V. N. Hardy and N. J. L. Megson on "The Chemistry of Silicon Polymers", by L. J. Haynes on "Physiologically Active Unsaturated Lactones", and by A. D. Walsh on "Far Ultra-Violet Spectra, Ionisation Potentials, and their Significance in Chemistry". The publication is intended to be of interest to chemists generally and not only to workers in the fields reviewed. A limited number of additional subscriptions for Vol. 2 can be accepted.

Erratum. We regret that the illustration accompanying the communication entitled "Eye Movements During Monocular Fixation" by Drs. Mary P. Lord and W. D. Wright (*Nature*, July 3, p. 25) has been printed upside down.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

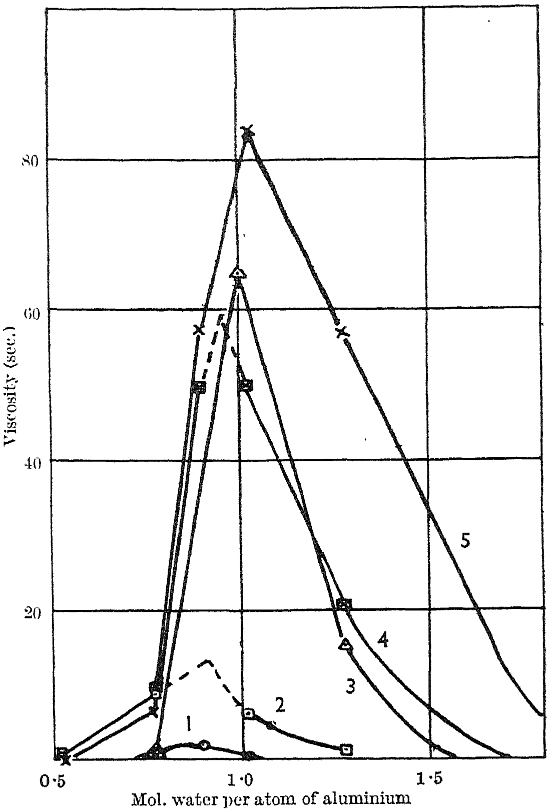
Role of the Hydroxyl Group in the Gelation of Aluminium Soaps in Hydrocarbons

In most of the early investigations, aluminium soaps were prepared by aqueous metathesis between a soluble soap and an aluminium salt. As pointed out by McBain[1], the result of reaction between a weak acid and a weak base is not likely to produce a stable salt. The tendency of aqueous solutions of aluminium salts to precipitate aluminium hydroxide over a range of *p*H is well known, so some at least of soap prepared by aqueous metathesis is likely to consist of fatty acid adsorbed on to precipitated aluminium hydroxide. Analogous to the alumino silicates, alums, etc., one could associate a co-ordination number of four or six with aluminium, giving many different possibilities of co-ordination with fatty acid radical, undissociated fatty acid and water. When the effect of *p*H, heat and method of preparation on such a heterogeneous system[2] is considered, it is not surprising that results are difficult to duplicate.

At ordinary temperatures, soaps prepared by the above method have a negligible solubility in hydrocarbons, and tend to gel. On the other hand, a fatty acid and an aluminium alcoholate, when moisture is rigorously excluded, react exothermically to give a product which is extremely soluble in benzene and does not gel. A study of benzene solutions of these aluminium 'soaps' prepared in the absence of water has given some interesting results. In each case the 'soap' is prepared *in situ*, and so the solution contains some free alcohol.

(1) The addition of very small amounts of water causes a marked gelling and increase in viscosity even at low concentrations of soap. A quantitative study of this is presented in the accompanying graph. In this case the equivalent of two molecules of fatty acid per molecule of aluminium alcoholate, $Al(OR)_3$, was allowed to react in a solution containing 2·66 per cent aluminium *sec.* butylate, and the viscosity was plotted against the number of molecules of water per atom of aluminium. The viscosity is anomalous and is therefore given as the time of fall of a 3/32-in. diameter steel ball through 5 cm. of the system. Within experimental error, it can be seen that in each case the viscosity rises to a steep maximum at the equivalent of one molecule of water per atom of aluminium, and then falls sharply until at about the equivalent of 2 moles of water precipitation of soap begins. The position of the maximum viscosity is independent of the relative or total amounts of fatty acid and alcoholate allowed to react together; however, in the region of 1·0 mole of fatty acid per mole of alcoholate, precipitation and heterogeneity make results unreliable. The highest maximum is produced by 2 moles of fatty acid per mole of alcoholate.

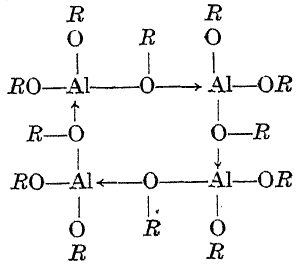
(2) It is possible to obtain reproducible, rather unstable solid monolayers by spreading on water a benzene solution of soap, prepared anhydrously as above. The compressed monolayers, which will stand pressures up to 50 dynes per cm. for a few minutes, show an area of 19 A.^{2} per molecule of fatty acid, provided the molecular ratio of fatty acid to alcoholate exceeds 1·5. Below this, a considerable decrease in area is observed, indicating that fatty acid has been removed from the surface.



CURVE 1, BUTYRATE ; 2, CAPROATE ; 3, DECANOATE ; 4, LAURATE ; 5, PALMITATE

Results further confirm the conclusions of other workers[1,3] that the aluminium tri-soap, empirically $Al(OF)_3$, does not exist, and that at most two fatty acid molecules react with one of alcoholate to give a di-soap mono-alcoholate $Al(OF)_2OR$. The change in viscosity, on addition of water to the freely flowing solution of the anhydrously prepared soap, demonstrates the essential part played by the hydroxyl group in the gelation of aluminium soaps in hydrocarbons. The fact that the water reacts exothermically, releasing alcohol, and that the product of reaction is similar in all properties to the di-soap prepared by aqueous metathesis, leaves little doubt that a hydroxy compound is being formed.

Robinson and Peak[4] have shown that aluminium alcoholates exhibit fourfold polymerization, $[Al(OR)_3]_4$, in organic solvents such as benzene, naphthalene and butyl alcohol, and offer inconclusive evidence that this polymerization persists in the vapour state. They have suggested a stable octahedral structure for these alcoholates, which, when modified[3], may be written:



This structure would account satisfactorily for the stability, low melting points and boiling points and other properties of aluminium alcoholates. It indicates, too, that two alcoholate groups would react differently from a third; this partially steric effect could account for the difficulty of replacing three alcoholate groups by fatty acid.

On replacement of —O*R* by —OH, a more strongly electronegative group, the co-ordinate bond $-\overset{R}{O}\rightarrow Al$ is enormously weakened, allowing the possibility of disruption of the closed-ring polymer and the formation of long chains by hydroxyl bonding. Obviously this chain formation, and so gelling, is at a maximum when one —OH group is attached to each aluminium atom, and begins to fall off as other compounds such as water, amines, phenols, etc., which compete for hydroxyl bonds, are introduced. This agrees with practice. The lack of gelling power shown by aluminium mono-soaps can be explained by intra-molecular hydroxyl bonding.

An aluminium soap hydrocarbon gel can then be considered as made up of very large molecules loosely held together by (1) hydroxyl bonds, (2) Van der Waals attraction of long hydrocarbon chains. That a balance between these two types of bond exists is shown by the fact that equal concentrations (by weight) of soaps of varying chain-length show little variance in visco-elastic properties, as compared with the large differences shown by the equimolecular concentrations of the different long-chain soaps (see accompanying graph).

The influence of a third possible linkage, from the carboxyl group of the soap, $C=O\rightarrow Al$, is being investigated. Details will be published elsewhere.

We are grateful to the chief scientist, Ministry of Supply, for permission to publish this communication.

T. S. McRoberts
J. H. Schulman

Department of Colloid Science,
University, Cambridge.
March 10.

[1] McBain, J. W., and McClatchie, W. L., *J. Amer. Chem. Soc.*, **54**, 3266 (1932).

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Processing Thick Emulsions for Nuclear Research

In the application of the photographic method to research in cosmic-ray and nuclear physics, the need has always been felt for emulsions of thickness comparable with the range of the particles to be recorded. The use of thick emulsions has been greatly restricted, however, by the difficulties met in processing them. It has been possible to use plates with emulsions 200 μ thick but, using conventional methods, the degree of development is found to be much greater at the top than at the bottom of the emulsion. It follows that the grain density, in the tracks of particles of the same ionizing power, varies with the depth of the track; a result which leads to great difficulty in interpreting the experimental material even in experiments where it is possible to use short exposures so that complications due to fading are not present. We give here a brief outline of a method of processing which has enabled us to produce a nearly uniform development of emulsions 300 μ thick, so that the grain density in the tracks of particles in regions of equal ionization does not vary by more than 10 per cent from the top to the bottom of the emulsion.

To secure uniform development, we must in principle make sure that the developer has time to permeate the emulsion before it acts. This might be achieved by soaking for a long time in a developer which acts very slowly (by reason, for example, of low concentration of alkali, high concentration of restrainer, or low temperature). Alternatively, we may attempt to separate the processes of permeation and development. We have done this by cold soaking followed by rise of temperature, making use of the fact that the rate of permeation has a lower temperature coefficient than the rate of development.

The procedure is as follows: the plates are first soaked in water and then in cold developer. The temperature is next raised with the plates protected from a further increase in the concentration of the developing agent. After a suitable period of development, further action is checked in a cold stop bath; and the fixing is begun in a cold solution, the temperature of which is afterwards raised (see Fig. 1).

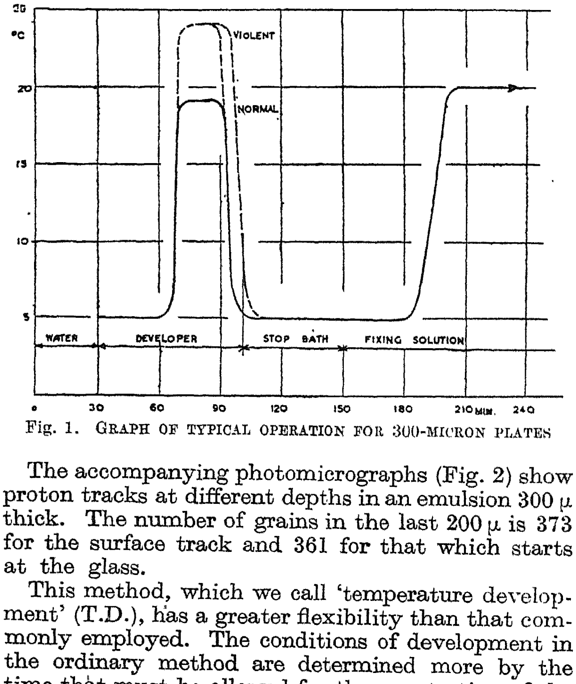

Fig. 1. Graph of typical operation for 300-micron plates

The accompanying photomicrographs (Fig. 2) show proton tracks at different depths in an emulsion 300 μ thick. The number of grains in the last 200 μ is 373 for the surface track and 361 for that which starts at the glass.

This method, which we call 'temperature development' (T.D.), has a greater flexibility than that commonly employed. The conditions of development in the ordinary method are determined more by the time that must be allowed for the penetration of the solution into the emulsion than by any other factor. In temperature development, most of the development takes place when the temperature is high, after the solution is nearly uniformly distributed through the plate. This makes it possible to achieve different degrees of 'discrimination' in the same type of emulsion, by varying the temperature and time of development and the composition of the developer.

A stringent test of the advantages of the method has been given by observations on β-ray tracks in the new Kodak X-ray emulsions[1]. Since the electron is highly scattered, it is difficult to find the complete track of a 100 keV. electron in an emulsion 50 μ thick. In the 100 μ and 200 μ emulsions, temperature development made it possible to follow the β-ray tracks to greater lengths than in normally developed plates. Moreover, by 'violent' uniform development,

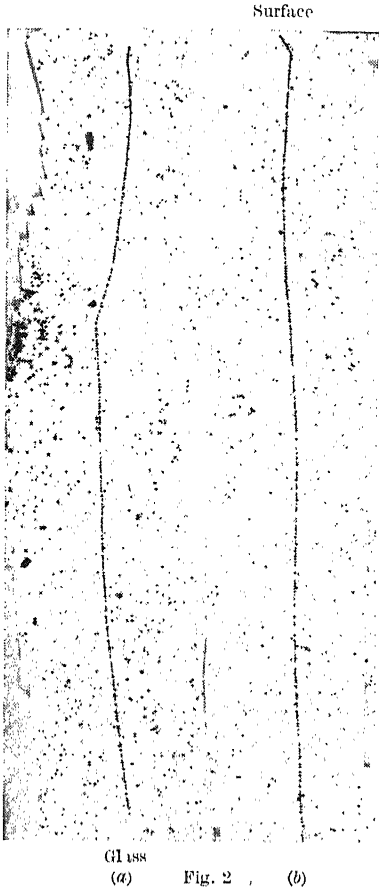

Fig. 2

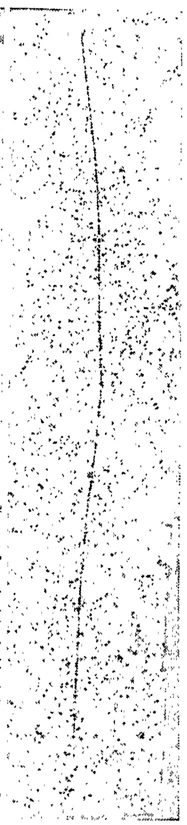

Fig. 3

Fig. 2. PROTON TRACKS IN A 300-MICRON PLATE. RECOIL PROTONS FROM NEUTRONS FROM A RADIUM-BERYLLIUM SOURCE. γ-RAY BACKGROUND

Fig. 3. PROTON TRACK IN A 700-MICRON PLATE. AVERAGE DEPTH OF TRACK, 680 MICRONS. HEAVY γ-RAY BACKGROUND

it is possible to detect the last grains of electron tracks at every depth, even in the Ilford emulsions.

We cannot give here a standard development procedure, for in the experimental plates on which we have been working the optimum conditions vary from batch to batch of the same nominal type of emulsion, and must therefore be found by trial and error. The strength of the developer must be adjusted to achieve penetration with little development during the cold stage, and the temperature raised for a time between 10 and 40 min., to between 18° and 30° C., according to the degree of discrimination required and to the composition of the plate. Boron 'loaded' plates always show considerable unevenness in development. The presence of local concentrations of the 'loading' salt results in 'islands' in the tracks, regions of exceptionally high grain density, and blistering due to local swelling. These drawbacks tend to offset the advantages which have been claimed for the use of these plates in cosmic-ray work[2].

By diminishing the activity of the developer, and increasing the time of cold soaking, 700 μ plates were processed without great difficulty (Fig. 3).

At such depths, the optical conditions become critical. Inhomogeneities and impurities in the upper layers of the emulsion impair the image in the microscope and lead to apparent 'scattering' of the tracks below. If the number of 'events' in the emulsion is too high, 'deep' tracks may be completely obscured. Some of the impurities can be removed by thorough washing in distilled water. The translucency of the emulsion can also be improved by immersing it in a second strong fixing solution after it has been washed and dried in the normal way. When it is possible to look from the other side of the emulsion[3], which can be done with an ordinary microscope if either a stripped emulsion or one backed by thin celluloid is used, the maximum thickness which it is possible to observe can be doubled. It seems now that the limit to the use of very thick emulsion is set by optical, rather than processing, difficulties.

We wish to express our gratitude to Dr. C. F. Powell for helpful discussions during the work; to Mr. C. Waller of Ilford, Ltd., and to Dr. W. F. Berg, Dr. R. W. Berriman, Dr. R. H. Herz and Dr. G. W. W. Stevens of Kodak, Ltd., who prepared the special emulsions for us. We wish also to thank Mr. E. Samuel for his invaluable help with the photomicrographs.

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May 20.

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[1] Berriman, *Nature*, **161**, 432 (1948).

[2] Lattes, Occhialini and Powell, *Nature*, **160**, 458 (1947). Leprince-Ringuet, Krakow Symposium (October 1947).

[3] Bates and Occhialini, *Nature*, **161**, 473 (1948).

Steric Hindrance in Vinyl-Mesitylene

A NUMBER of workers have observed various anomalous properties in nuclear-substituted derivatives of mesitylene, such anomalies usually being ascribed to restricted rotation about the bond connecting the substituent to the benzene ring caused by the two *ortho*-methyl - groups. In particular, Adams and Theobald[1] have resolved β-bromo-β-(3-bromo-2,4,6-trimethylphenyl)-acrylic acid and the corresponding β-chloro - compound into optically active forms, and have shown the half-life period of the latter to be much greater for the bromo- than for the chloro - compound (64 hr. and 200 min. respectively). Substitution of hydrogen for the halogen atom would clearly make resolution impossible. However, we have recently shown that restriction of rotation is still appreciable even with such a small 'blocking' group as hydrogen, by a study of the simplest possible compound of this class, namely, vinyl-mesitylene.

The abnormality of this hydrocarbon, as compared with similar compounds in which the vinyl group is not 'blocked' by two *ortho*-methyl - groups, is apparent in the values of most of its physical constants such as freezing point, boiling point, refractive index and specific dispersion. The ultra-violet absorption spectrum shows the typical reduced absorption observed by various workers for mesitylene compounds containing larger groups, such as aceto-[2], and nitro-[3], substituted in the benzene nucleus. The infra-red absorption spectrum shows differences from the spectra of styrene and *meta*- and *para*-methylstyrene in the regions characteristic of vibrations of the vinyl group, supporting the hypothesis that 'blocking' in the *ortho* - positions affects the electronic structure. These effects can best be explained in terms of restricted rotation about the C—C bond which attaches the vinyl - group to the nucleus, thus hindering the assumption of a coplanar configuration and hence the resonance of the external double bond with the nucleus.

The most remarkable manifestation of this effect is the greatly reduced tendency of this hydrocarbon to polymerize, which was first noticed by Klages[4]. It has been found to undergo no measurable change in two weeks at 100° C., whereas the polymerization of styrene and other nuclear-methylated homologues containing at least one unsubstituted position *ortho*- to the vinyl - group is about 90 per cent complete after two or three days at this temperature. Polymerization to an extremely brittle polymer of low molecular weight was effected by heating at 190° C. for several days, and also at room temperature in the presence of about 1 per cent of stannic chloride as catalyst.

Since 2,6-dichloro-styrene has been reported to polymerize readily[5], it is possible that some electronic interaction, such as the reversed field effect of the *ortho*-methyl - groups[6], is also of importance in causing the stability of vinyl-mesitylene.

There is a close analogy in steric terms between vinyl-mesitylene and α-methyl-styrene, for, in the former, the relevant rotation is hindered by the two *ortho*-methyl - groups, and in the latter the two *ortho*-hydrogen atoms interfere with the methyl - group on the rotating propenyl - group. This analogy extends to the physical properties and polymerization characteristics of the two compounds[7].

We are indebted to Dr. H. W. Thompson for the infra-red measurements, and to the directors of Trinidad Leaseholds, Ltd., for permission to publish this note ; a full account of the work will be published elsewhere.

F. R. Buck
G. T. Kennedy
F. Morton
E. M. Tanner

Trinidad Leaseholds, Limited,
Central Laboratory,
King's Langley,
Herts.
March 30.

[1] Adams, R., and Theobald, C. W., *J. Amer. Chem. Soc.*, **65**, 2383 (1943).

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Electric Dipole Moments of Some Styrenes

The electric dipole moments, in benzene solution at 25° C., of the following nuclear methylated styrenes have been measured :

(I)	*p*-methyl-styrene	$0\cdot38 \pm 0\cdot1\,D$
(II)	*m*-methyl-styrene	$0\cdot36 \pm 0\cdot1\,D$
(III)	2,4,5-trimethyl-styrene	$0\cdot45 \pm 0\cdot1\,D$
(IV)	2,4,6-trimethyl-styrene	$0\cdot42 \pm 0\cdot1\,D$

These values are approximately corrected for atom polarization. Otto and Wenzke[1] report a value of $0\cdot63\,D$ for (I). The others appear not to have been examined.

The moment of toluene is $0\cdot35\,D$ in the gas phase, corrected for atom polarization[2] ; so the values found for (I), (II) and (III) are consistent with the moment of styrene being very small, and with there being very little induction of a moment in the vinyl- grouping by the *o*-methyl - group in (III). Direct measurements on styrene leave uncertainty about its moment ; but this is probably not greater than $0\cdot37\,D$[1,3,4,5].

The moment of (IV) is therefore larger than is consistent with the other values. The most obvious cause of this anomaly (see preceding communication ; cf. Hampson and co-workers)[6] is that in (IV) the *o*-methyl - groups prevent the vinyl - group assuming a configuration co-planar with the benzene ring, as it would need to do to be in the best position for forming π-bonds therewith.

This explanation implies that the moment of the styrene molecule in which π-bonding is prevented may be as large as $0\cdot4\,D$, though there is no evidence as yet to show which pole is nearer to the benzene ring.

If this be so, then whichever is the direction, the moment is different from that actually found for styrene, and this indicates that the π-bonding in the latter causes a moment which may be *c.* $+ 0\cdot1$ to $+ 0\cdot4$, or $- 0\cdot4$ to $- 0\cdot7\,D$; that is, there is a permanent electron drift tending to cause either *ortho*-, *para*- or *meta* - direction in the ring. The latter seems to us unlikely, but until the direction of the moment of (IV) has been established, no certain answer can be given to this question.

A further implication is that in the 'inhibited' styrene either the σ-bond skeleton is polar, or the moment of the C—H bond is different in benzene and in ethylene, or both are true.

There appears also to be a difference between the moments of styrene and of triphenylethylene ($0\cdot6\,D$[3]), which may arise in the same way.

We are indebted to Mr. G. T. Kennedy for bringing this problem to our notice, and for supplying the compounds.

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March 30.

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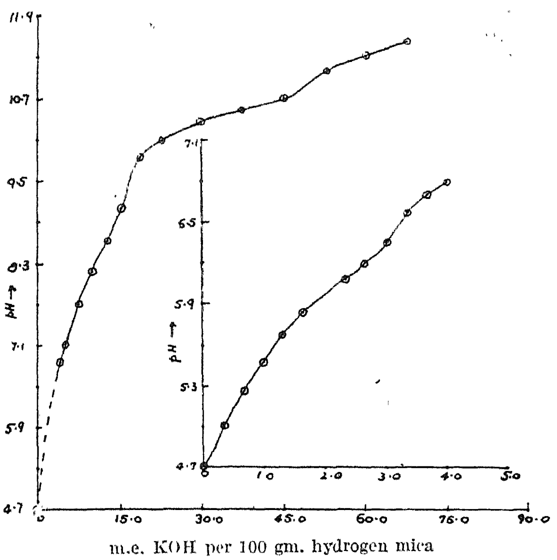
Titration Curves of Hydrogen Micas

The titration curves of a number of micas have been studied as a part of a scheme of work on the electrochemistry of structurally well-known crystals in finely ground states. Some typical results obtained with muscovite are given below. Details will be published elsewhere.

The finely ground material having particles with 'equivalent spherical diameters' smaller than $2\cdot0$ microns was leached with dilute hydrochloric acid to obtain the hydrogen- or acid-mica by the replacement of the exposed potassiums by hydrogen ions. Potentiometric titration curves of hydrosols of this hydrogen mica with bases show three inflexions, the first of which is often very weak while the other two are quite prominent. The *p*H values at the inflexions as well as the form of the titration curve depend, to some extent, on the nature of the base used. Titration with sodium or potassium hydroxide gives the first inflexion at a *p*H between $6\cdot15$ and



7·3; the second and third inflexions occur near *p*H 9·0 and 10·5, respectively. A typical titration curve obtained on titrating a 1·0 per cent sol with potassium is shown in the accompanying graph. The initial (dotted) portion of the curve, drawn separately on a different scale to bring out the first (weak) inflexion clearly, resembles that of a weak acid. Pauling[1], on the other hand, had predicted a very strong acid character of hydrogen mica.

Practically all the buffer action of the sol, especially the buffering beyond the first inflexion, is observed at *p*H values much higher than the range of *p*H (approximately 4·14–5·0) within which aluminium hydroxide is precipitated[2]. No aluminium could be detected in the clear supernatant liquid of a mixture of the sol and potassium chloride in which the concentration of the salt was as high as 1·0 *N*. This supernatant liquid had a much lower *p*H than the pure sol, and it contained an amount of titratable acid which is approximately equal to—in some cases, it is appreciably less but never greater than—that obtained at the first inflexion of the titration curve of the pure sol with potassium hydroxide.

The acidity value calculated at the second inflexion of the titration curve of the sol in terms of milli-equivalents per 100 gm. of dry matter is, in all cases, equivalent to the quantity of potassium ions displaced from the ground muscovite in preparing the hydrogen system, and it indicates that this inflexion marks the completion of the neutralization of hydrogen ions acquired by the surface in exchange for the exposed potassium ions of the platelets. The acidity values calculated at the third and second inflexions are as 3 : 1, the actual values in the case of the specimen the titration curve of which is reproduced being, respectively, 16·0 and 47·5 milli-equiv. per 100 gm. This is just what would be expected if the two hydroxyl groups reckoned for each hydrogen ion of the above category in the hydrogen mica (to which the formula $H(Al_2)(Al\,Si_3)O_{10}(OH)_2$ can be given in the case of muscovite) reacted with the base at the third, or final, inflexion. Actually, for each such H ion, two structurally identical OH groups are available for interaction with the base through hexagonal rings of oxygens. The portion of the titration curve between the second and third inflexions, therefore, appears to indicate the neutralization of hydrogen ions dissociated from these hydroxyl groups.

The bearing of the above results on the question of the nature of heterogeneous acid systems and, in particular, on the buffer action and cation-binding power of clays and clay minerals which also have a micaceous structure, will be fully discussed elsewhere.

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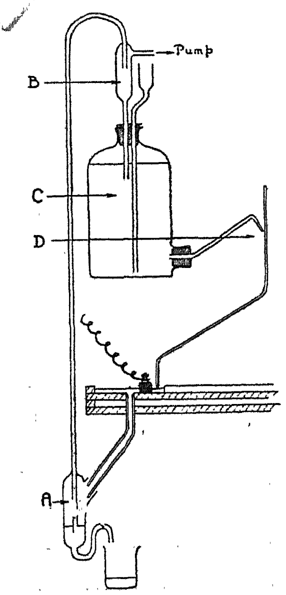
A Modified Ionophoresis Apparatus

Consden, Gordon and Martin[1] have described an apparatus for the electrophoretic separation of molecules of low molecular weight in a solid medium. They show that rapid perfusion of the electrodes of such an apparatus is essential, in order that, even after the potential has been applied for some considerable time, there may be no appreciable change in *p*H at the gel/liquid interface due to increased ionic concentration at this point. In the apparatus described in their paper, the perfusion buffer is lost, since, after bathing the electrodes, it passes into the cooling chamber beneath the gel trough, and so to waste. Two considerations led me to explore the possibilities of separating these two liquids.

First, it appeared desirable in certain cases to be able to obtain in solution amino-acids which had run the full length of the gel, by collecting fractions of the perfusate as the bands reached the electrode compartments. Secondly, since the time taken for the first band to traverse the length of the gel might be a period of many hours, and similar intervals might occur between successive bands, it appeared desirable to conserve the buffer solution during those periods when no amino-acids were passing across the gel/buffer interface. With this in view, various alterations and additions were made to the apparatus as described by Consden *et al.*



CIRCULATING DEVICE FOR CONTINUOUS ELECTRODE PERFUSION

A tube was inserted in the base of the electrode compartment in place of the aperture giving direct access to the cooling trough. Through this the buffer was able to flow directly into a sump (*A*) beneath the apparatus. The surface of the liquid in this sump was maintained at a constant level by means of an intermittent air-lift pump connecting the sump by means of a vertical tube having a diagonally ground tip, with a subsidiary reservoir (*B*) above the Marriotte bottle (*C*) containing the main store of buffer. The decreased pressure activating the air-lift device was provided by a water pump connected to the reservoir, from the base of which a tube led into the Marriotte bottle, terminating below the surface of the liquid. Provision was made for maintaining the volume of buffer in the system by combining a funnel with the vertical tube in the Marriotte bottle which governed the flow of liquid from the jet. This jet (*D*) was allowed to impinge on the surface of a glass rod which led the buffer into the electrode compartment. Such an arrangement permitted the rate of flow to be accurately controlled, since the difference in levels between the jet and the bottom of the funnel stem could be altered at will without affecting the rest of the apparatus. Variations in the water pressure to the pump were shown to cause the level of liquid in the sump to rise to such a height above the tip of the vertical tube that air was no longer able to enter at the bottom, with the resultant stoppage of circulation. This was obviated by the incorporation of a syphon in the sump to maintain the surface of the liquid at the level of the tip of the vertical tube. Two sets of apparatus, one for each electrode compartment, were attached to the same vacuum line, in order that the rate of flow to each electrode might be identical.

In runs of eight hours or more, using a neutral gel and phosphate buffers, the *p*H of the perfusates was not found to vary by more than 0·1 *p*H unit, except during those periods when acidic or basic amino-acids were leaving the gel. These fractions, and those of other amino-acids, were collected by interrupting the return of the buffer to the reservoir and substituting a receiver for the sump. The arrival of any band at the gel/buffer interface was calculated from the relative displacements of the bands as determined by the 'printing' method of the original authors. Two such prints were taken at intervals during the course of a run; this necessitated the use of a trough without a lid, but no trouble due to swelling or contraction of the gel was encountered. It was found that the ionic concentration in the gel remained sufficiently constant during any one run for the relationship between time and distance to be taken as linear.

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Absorption of Ultrasonic Waves in Acetic Acid

THERE are broadly three possible causes of absorption of ultrasonic waves in liquids. The first two are viscosity[1] and conduction of heat[2]; these give rise to an absorption the coefficient α of which varies as the square of the frequency ν at all frequencies[3,4]. The third general cause is the perturbation by the wave of any equilibrium that may be set up in the liquid, if the new equilibrium state is attained exponentially, with a 'relaxation' time constant. The equilibrium may be chemical[5], or one involving the various degrees of freedom contributing to the specific heat[3], or between molecules arranged in an orderly structure and others arranged at random[6]. Whatever the mechanism responsible for the relaxation time, Kneser[7] has shown that it will contribute an additional absorption α, which is a function of the frequency ν. He has shown that for frequencies considerably below a relaxation frequency, α varies strictly as ν^2; considerably above this frequency it becomes constant; the quantity $\mu = \alpha\lambda = \alpha . c/\nu$ reaches a maximum value at the relaxation frequency.

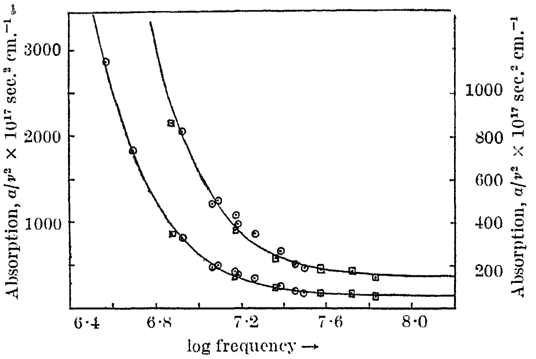

Fig. 1. ABSORPTION IN ACETIC ACID. POINTS IN CIRCLES, BAZULIN'S RESULTS; POINTS IN SQUARES, AUTHOR'S RESULTS. UPPER CURVE REPRESENTS PART OF THE LOWER CURVE ON A LARGER SCALE

If we find a case where α is not strictly proportional to ν^2, then it may be possible to distinguish between differing causes of absorption acting at the same time in the liquid. A good example is provided by acetic acid. A plot of α/ν^2 against log ν (Fig. 1) for this liquid shows that at high frequencies α/ν^2 tends to a constant value of about 155×10^{-17} sec.^{2} cm.$^{-1}$. At lower frequencies it rises greatly, suggesting a relaxation frequency at some lower frequency. The experimental results are due to Bazulin[8] and some recent measurements I have made, which are in good agreement with one another. The temperature was 16–17° C. for most of the observations.

If we postulate that the value of 155×10^{-17} represents the absorption due to viscosity, heat conduction and any relaxation process the relaxation frequency of which is well above 10^8 c.p.s., then it is permissible to subtract this amount from the values of α/ν^2 at all frequencies below 10^8 c.p.s. The remaining attenuation is then presumably due to a single relaxation process at around 2×10^6 c.p.s., and it is possible to make a quantitative test of Kneser's equation (14)[7]:

$$\alpha/\nu^2 = \frac{2\mu_m}{c \, . \, \nu_m \, (1 + (\nu/\nu_m)^2)} .$$

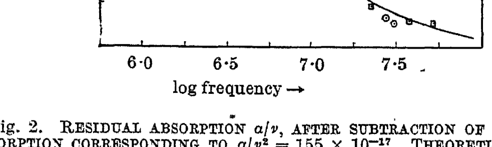

Fig. 2. RESIDUAL ABSORPTION α/ν, AFTER SUBTRACTION OF ABSORPTION CORRESPONDING TO $\alpha/\nu^2 = 155 \times 10^{-17}$. THEORETICAL VALUES ON CURVE. POINTS IN CIRCLES, BAZULIN'S RESULTS; POINTS IN SQUARES, AUTHOR'S RESULTS

At low frequencies $\alpha/\nu^2 \approx 2\mu_m/c.\nu_m = A$, say. Kneser's equation can then be put in the form

$$1/\alpha = 1/A(1/\nu^2 + 1/\nu_m^2),$$

and may be tested by plotting $1/\alpha$ against $1/\nu^2$. This plot yields the best values of A and ν_m to fit the experimental points; from the plot we find $A = 12{,}000 \times 10^{-17}$ sec.^{2} cm.$^{-1}$ and $\nu_m = 2\cdot0 \times 10^6$ c.p.s. These constants can be used to calculate the theoretical variation of α/ν, which is proportional to μ. In Fig. 2 the expected variation of α/ν as a function of log ν is represented by the solid line, and the points are observed values of α/ν, after subtraction of the absorption corresponding to $\alpha/\nu^2 = 155 \times 10^{-17}$ sec.^{2} cm.$^{-1}$. The agreement with theory is good and suggests that the extra absorption is correctly ascribed to some phenomenon with a relaxation time of 5×10^{-7} sec.

The process responsible for the absorption in this case is very probably the chemical equilibrium between the dimer and the monomer of acetic acid. The rate of this reaction, and consequently ν_m, should increase rapidly with temperature. Experiments to find the temperature dependence of ν_m are in progress.

Kneser's relation (11) also enables an estimate to be made of the total change in velocity to be expected corresponding to the fall in α/ν^2. For

$$\frac{\Delta c}{c} \approx \frac{\mu_m}{\pi} = \frac{\alpha c \nu_m}{\pi \nu_m^2} = A \cdot \frac{c \nu_m}{2\pi}.$$

Using the values of A and ν_m quoted above, and putting $c \approx 1 \times 10^5$ cm. sec.$^{-1}$, we find

$$\frac{\Delta c}{c} \approx 4 \times 10^{-3}.$$

It seems likely that such a small change in velocity will be hard to find, due to the heavy absorption in the frequency-range concerned. The 1 per cent dispersion reported by Spakowski[9] between 0·2 and 3 Mc./s. appears to be roughly confirmed.

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Crystal Structure of *B*-Starch from X-Ray Fibre Diagrams

IN recent papers[1], Kreger has published fibre data from the *B*(tuber)-modification of starch. Though his technique is new and interesting, Kreger's results mainly confirm data which were published some years ago[2]. Apparently the earlier fibre diagrams were more highly orientated than Kreger's, since the fibre spacing (10·6 ± 0·1 kX.) could be obtained unambiguously from these diagrams. More recently, both *B* and *A* (cereal-type) fibres have been prepared by new techniques with truly extraordinary orientations[3]. The fibre spacing of the *A*-modification (10·5 kX.) is substantially equal to that of the *B*-modification, a result not unexpected, since Bear and French established a very close relationship between these modifications of starch[4].

From the fibre diagrams a unit cell and rough structure for the *B*-modification of starch have been proposed[2]. The orthorhombic unit, $a = 16\cdot0$, b (fibre) $= 10\cdot6$, $c = 9\cdot1$ kX., is essentially the same as suggested in Kreger's first paper. More recently, Kreger has criticized this unit on the grounds that it leads to an X-ray density (1·60) no greater than the observed density of starch under water (1·60–1·63)[1]. The X-ray density was calculated assuming that the hydration of *B*-starch amounts to one water molecule per glucose residue.

The degree of hydration assumed by Kreger is apparently about right for the *A* modification of starch; but there is considerable reason for believing that the ideal hydration of the *B*-modification is higher. Thus, air-dried corn starch and the cereal starches contain about 10 per cent moisture, while tapioca, potato and other tuber starches normally contain about 15–20 per cent (between 1½–2 water molecules per glucose residue[5]). Moreover, it has been noted that the tuber starches especially yield much sharper X-ray diagrams when thoroughly wet with water[4], indicating that a very high degree of hydration is ideal for the crystalline portions of *B*-starch. It seems not unreasonable that at the ideal composition of the *B*-modification there are as many as two water molecules per glucose residue. In this case, the X-ray density would be 1·67, certainly high enough for a carbohydrate and in very satisfactory agreement with observed densities of starch under water (1·60–1·63)[1].

The difficulty in understanding the fibre spacing of starch, noted by Kreger[1], has been discussed before[2]. However, the lower fibre spacing found from space models is sensitive to angles in the glucose ring and in the glucosidic bond, and the proposed structure cannot be eliminated by considerations of only those models which have tetrahedral or other idealized angles.

In considering the possibility of an error in the suggested unit cell for *B*-starch, it seems well to point out that the difficulties in interpretation of fibre diagrams usually arise from screw axes or centring which eliminate the first-order spacings of the non-fibre axes. The *B*-modification of starch, in the present interpretation, has a screw axis only along the fibre axis, the spacing of which is not in doubt. The *a*-axis of the proposed unit cell is just the Bragg spacing of the lowest-order reflexion on the equator of the fibre diagram. This leaves no further room for manipulation of lattice parameters from fibre data for an orthorhombic unit, and makes it nearly certain that no simpler unit for the *B*-modification can be found.

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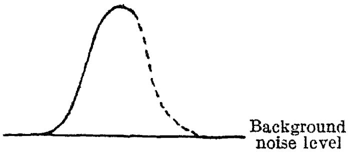
Shape of Pulses of Radio-frequency Radiation from the Sun

DURING some 400 hours observations of solar radiation on 75 Mc./s., the variation of the second detector anode current was recorded with a portable vibration galvanometer tuned to resonance at about 45 c./s. and damped less than critically, but so that the spot became stationary after sudden deflexions in less than 0·25 sec. Records were taken on 35-mm. film moving 12·1 mm./min. The gain was adjusted so that the current due to noise generated in the receiver was about 15 per cent of the maximum allowable, to avoid distortion in all but exceptional cases.

Ninety-nine single pulses of radiation lasting a few seconds each were observed sufficiently clear of overlapping pulses to give reason to believe that their shape on the film was a faithful record (by the linear detector) of the variation of radiated power from the source of the solar noise.

The 'tail' of such a pulse may indicate the manner of decrease in radiation by the source when it is no longer subject to the influence of an exciting agency, or, if the decay of the source under such conditions is very rapid, the curve will simply reflect the decrease in influence of the exciting agency. An analysis of the shape of the 'tails' of 78 such pulses was made after projecting the record, with magnification about 30 ×, and tracing the centre line of the photographic trace of the galvanometer spot. Twenty-one were not analysed, for the reason that the height of the pulse peak above background was less than 25 per cent of the background value, and too short a length of falling slope was available to enable significant measurements to be made. Fifty-eight were found to be very probably exponential in shape, eleven less probably so, four probably not so and five definitely not.

Between three-quarters and nine-tenths of the portion of the broken-line curve in the accompanying figure was analysed, and the deviation from average of the factor x in $\exp(-xt)$ was less than ± 15 per cent for those assumed to have exponential form.



TYPICAL PULSE SHAPE. PORTION OF CURVE EXAMINED, - - - -

The times taken for radiated power to decrease to half in the pulses of exponential shape are tabulated below:

Half-life (sec.)	0·4–0·6	0·6–0·8	0·8–1·0	1·0–1·2	1·2–1·4	1·4–1·6	1·6–1·8	1·8–2·0	2·0–2·2	Over 2·2
No. of pulses	5	8	12	13	8	7	3	0	2	nil

Included in the table above are thirty pulses occurring either consecutively, or within a short interval. These follow:

Date	Time interval	Half-value times (sec.)
27.5.47	30 sec. (con.)	0·75, 0·65
4.6.47	30 sec. (con.)	1·4, 0·9
22.7.47	30 sec. (con.)	0·9, 0·9
23.7.47	1 min. (con.)	1·2, 0·85
25.7.47	30 sec. (con.)	1·1, 1·1
7.8.47	30 sec. (con.)	0·7, 0·8
7.8.47	30 sec. (con.)	0·8, 1·3
12.8.47	40 sec.	1·2, 1·75, 1·35
30.9.47	5 min.	1·0, 0·85, 0·9, 1·0, 0·5, 1·1
30.9.47	1 min.	0·9, 1·05, 1·0
30.9.47	30 sec. (con.)	1·7, 1·1
30.9.47	30 sec.	0·9, 1·8

Although it might be assumed that pulses closely connected in time come from the same region and should therefore show similar half-value times, the results given above do not offer firm support for such a hypothesis.

No success was obtained from attempts to interpret the rising portion of the pulse curve in terms of exponential functions.

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Spectrum of Iodine Oxide (IO) in Flames

BANDS attributed to iodine oxide (IO) were observed by Vaidya[1] in a flame of methyl iodide, and analysed into two systems, *A* and *B*. More recently, Blake and Iredale[2] have published a revised analysis for system *A*; when this formula was used to arrange the bands, an obviously unsatisfactory intensity distribution was obtained. We have re-measured the bands, and extended the system to longer wavelengths. It is now found that all the bands can be arranged into one system instead of two, this system being an extension of the *B* system, with modified values of v''. The bands are listed in the accompanying table; intensities are visual estimates making some allowance for variations of plate sensitivity with wave-length.

BAND HEADS OF IO

λ	Int.	ν	v',v''	λ	Int.	ν	v',v''
4189·0	5 v.d.	23865	5,0	5208·8	5	19193	2,5
4286·2	7 d	23422·5	4,0	5248·7	1	19047	3,6
4355·9	9	22951	3,0	5307·5	10	18836	0,4
4396·7	6 d	22738	4,1	5345	1	18704	1,5
4448·7	7	22472	2,0	5385·5	2	18563	2,6
4487·7	10	22277	3,1	5422	4	18438	3,7
4548·1	3	21981	1,0	5495	9	18192	0,5
4586·7	10	21796	2,1	5533	7	18069	1,6
4624·9	5	21616	3,2	5655·5	2	17677	4,9
4668·3	2	21415	4,3	5692	7	17565	0,6
4693·5	9	21300	1,1	5730	8	17447	1,7
4731·2	7	21130·5	2,2	5767	4	17334	2,8
4763·3	4 d	20988	3,3?	5900	5	16945	0,7
4806·1	3	20801	0,1	5939	6	16832	1,8
4844·5	10	20636	1,2	5976	7	16729	2,9
4920·9	3	20316	3,4	6152·5	3	16240	1,9
4963·6	6	20141	0,2	6193	4	16142	2,10
5002·3	6	19985	1,3	6231·5	4	16043	3,11
5049·8	2	19797	2,4	6273	3 d	15937	4,12
5131·0	9	19484	0,3				

d = diffuse. v.d. = very diffuse.

The following are the molecular constants:

$$\nu_e = 21{,}565 \text{ cm.}^{-1} \quad \omega_e'' = 687 \text{ cm.}^{-1} \quad x_e''\omega_e'' = 5 \text{ cm.}^{-1}$$

$$\omega_e' = 512 \text{ cm.}^{-1} \quad x_e'\omega' = 5 \text{ cm.}^{-1}$$

A graphical Birge – Sponer extrapolation gives a dissociation energy for the ground-state, $D_0 = 1\cdot9 \pm 0\cdot2$ eV. or 44 k.cal. Bands with $v' = 4$ are diffuse, and the 5,0 band is very diffuse; this is probably due to pre-dissociation. The band system for IO is now closely analogous to the systems recently reported[3,4] for ClO and BrO. This analysis gives a normal vibrational intensity distribution as shown in Fig. 2. The IO bands have been obtained when iodine is added to an oxyhydrogen flame, thus supporting the assignment to IO and eliminating CI.

When iodine is added to a methyl alcohol/air flame a strong band, or region of continuum, with a sharp head at 4045 A., degraded to shorter wave-lengths, is obtained. A similar but weaker band, at about 3670 A., is obtained when bromine is introduced into a methyl alcohol flame. The emitters of the bands are not known.

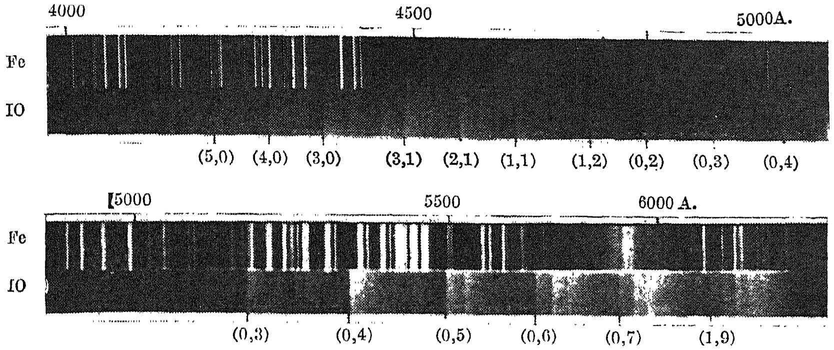

Fig. 1. SPECTRUM OF FLAME OF METHYL IODIDE PLUS HYDROGEN IN OXYGEN

v' \ v''	0	1	2	3	4	5	6	7	8	9	10	11	12
0	·	3	6	9	10	9	7	5	·	·	·	·	·
1	3	9	10	3	·	1	7	8	6	3	·	·	·
2	7	10	7	·	2	5	2	·	4	7	4	·	·
3	9	10	5	4?	3	·	1	4	·	·	·	4	·
4	7	6	·	2	·	·	·	·	·	2	·	·	3
5	5	·	·	·	·	·	·	·	·	·	·	·	·

Fig. 2

One of us (E. H. C.) is indebted to the director of the Department of Scientific and Industrial Research and Fire Offices' Committee Joint Fire Research Organisation for permission to publish this communication.

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Hydride and Deuteride Bands of Aluminium, Copper, Silver and Gold

AN investigation of the spectra mentioned above has been undertaken with a water-cooled hollow cathode of Schüler type with helium filling. The break-off in the CuH-band λ 4280 found by Schüler and Gollnow is unique, and does not appear in any of the spectra of the above-mentioned metals. The experimental results show that the interpretation given by Herzberg and Mundie is correct.

On long exposure at the lowest possible pressure (0·03 mm.), the AlH-band λ 4240 shows a very sharp break-off with $P(19)$ as the last line in the P branch.

A detailed account of these experiments is to be published elsewhere.

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Relation Between the Brunauer – Emmett – Teller and Harkins–Jura Isotherms

H. K. LIVINGSTON[1] has recently attempted to relate the Brunauer – Emmett – Teller and Harkins – Jura equations by means of the Gibbs adsorption isotherm for solid surfaces. However, he has only applied his method to one of the limiting conditions of the Brunauer – Emmett – Teller equation. We have extended this method to include the complete form of the equation, in order to direct attention to the great importance of the value of constant n in these relations.

The Harkins – Jura equation

$$\log p = B - A/v^2 \qquad (1)$$

(v is the volume of gas adsorbed at pressure p, A and B are constants) was obtained by substitution in the equation of state for condensed films :

$$\pi = b - a\sigma \qquad (2)$$

(where π is surface pressure, σ is area per molecule of adsorbate, and a and b are constants).

The Brunauer – Emmett – Teller equation may be expressed in the complete form :

$$v = \frac{v_m c.p}{p_0 - p} \cdot \frac{p_0^{n+1} - p_0.p^n(n+1) + n.p^{n+1}}{p_0^{n+1} + p.p_0^n(c-1) - c.p^{n+1}} \qquad (3)$$

or in two limiting forms :

$$n = 1;\ v = \frac{v_m c.p}{p_0 + c.p};$$

$$n = \infty;\ v = \frac{v_m c.p.p_0}{(p_0 - p)(p_0 - p + c.p)}. \qquad (4) \text{ and } (5)$$

Livingston obtained the relations

$$k_1\pi = \log\left(\frac{p_0 - p + c.p}{p_0 - p}\right) \text{ and}$$

$$k_2\sigma = \frac{(p_0 - p)(p_0 - p + c.p)}{c.p.p_0} \qquad (6) \text{ and } (7)$$

(where $k_1 = V\Sigma/RTv_m$, $k_2 = Nv_m/V\Sigma$, V is the molar gas volume, and Σ is the specific surface of the adsorbent). He then calculated the conditions under which the values of $k_1\pi$ and $k_2\sigma$, for any given value of c, could be expressed as a linear relation equivalent to equation (2) :

$$k_1\pi = b' - mk_2\sigma. \qquad (8)$$

It follows from his reasoning that if the $k_1\pi - k_2\sigma$ relation is linear, then the pressure–volume adsorption isotherm may be expressed accurately by either the Brunauer – Emmett – Teller or Harkins – Jura equations.

Equations (6) and (7) are only valid for the limiting condition when $n = \infty$, being based on equation (5). In practice, it has been found that when $n > 5$, equation (5) represents the data fairly closely. However, with highly porous solids n is frequently less than 3, and equation (5) is no longer applicable. We have found, in adsorption experiments on highly porous amorphous carbons, that when $n < 3$, the Harkins – Jura plots of log p against $1/v^2$ are invariably curved. Similar results have been obtained by Joyner, Weinberger, and Montgomery[2]. The treatment of Livingston has, therefore, been extended to include equations (3) and (4).

From equation (3) we obtain:

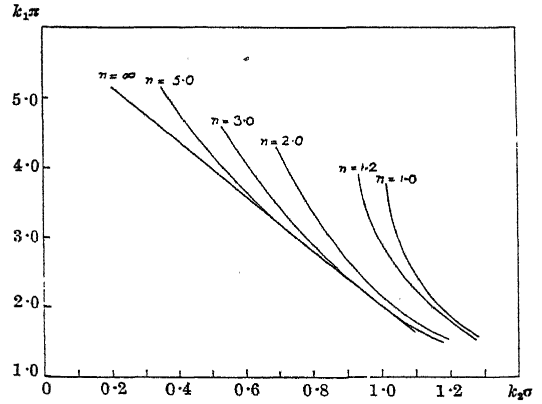
$$k_1\pi = \int_0^p \frac{c}{p_0 - p} \cdot \frac{p_0{}^{n+1} - p_0 . p^n (n+1) + np^{n+1}}{p_0{}^{n+1} + p . p_0{}^n (c-1) - cp^{n+1}}\, dp, \qquad (9)$$

$$k_2\sigma = \frac{p_0 - p}{cp} \cdot \frac{p_0{}^{n+1} + p_0{}^n . p . (c-1) - cp^{n+1}}{p_0{}^{n+1} - p_0 . p^n (n+1) + np^{n+1}}; \qquad (10)$$

From equation (4):

$$n = 1;\ k_1\pi = \log\left(\frac{p_0 + cp}{p_0}\right);\ k_2\sigma = \frac{p_0 + cp}{cp}. \qquad (11) \text{ and } (12)$$

The most general conditions are represented by equations (9) and (10). In order to discover the effect of low values of n, these equations were used to calculate the values of $k_1\pi$ and $k_2\sigma$ when $c = 50$, $p_0 = 800$, and $n = 1$, 1·2, 2, 3 and 5. Equation (9) was solved by graphic integration. The value of 50 was chosen for c, as Livingston showed that a longer linear portion on the $k_1\pi - k_2\sigma$ plot is obtained for this value of c than for any other value, when $n = \infty$. The results are shown in the accompanying graph. When $n \ll 5$, the $k_1\pi - k_2\sigma$ relation is no longer linear. The tendency to curve away from the $k_1\pi - k_2\sigma$ linear relation (when $n = \infty$) progressively increases as the value of n decreases. It appears that if $n \ll 5$, the conditions represented by equation (2) are no longer satisfied, and we should expect the plot of $\log p$ against $1/v^2$ to be curved. This is precisely what occurs.



EFFECT OF VARYING THE VALUE OF n UPON THE LINEARITY OF THE $k_1\pi - k_2\sigma$ RELATION

The physical significance of n is not known, but has been taken to depend mainly on the sizes of the pores. If this interpretation is correct, the above preliminary calculations indicate that when the average diameter of the pores becomes less than a certain critical value, the Harkins - Jura equation cannot be applied to the adsorption data.

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[1] Livingston, H. K., *J. Chem. Phys.*, 15, 617 (1947).

[2] Joyner, L. G., Weinberger, E. B., and Montgomery, C. W., *J. Amer. Chem. Soc.*, 67, 2182 (1945).

A Suggested Explanation of Sangster's Rotations and Schmidt's "Wandering Vortices" in Geomagnetism

A curious and hitherto unexplained phenomenon was discovered many years ago by Sangster[1] from a study of Greenwich magnetograms for periods of magnetic disturbance. He showed that the horizontal component of the disturbance vector at Greenwich rotates for considerable periods in the same direction, so that its end describes a sequence of loops, which vary greatly in size and shape but are all described in the same sense, when viewed, say, from above. From 10h. to 24h. almost all the rotations are anti-clockwise, while from 0h. to 10h. they are mostly clockwise.

The results of some calculations, made by Mr. A. Ashour and myself, of the currents induced in a *non-uniform* ionospheric shell by a varying external magnetic field, suggest a simple explanation of the above phenomenon.

We find that the induced currents form vortex systems the centres of which tend to move continually towards the point of highest conductivity, which we take to be the sub-solar point, B say. For example, a sudden increase in an inducing field parallel to the earth's axis produces a system of currents initially along circles of latitude, so that the corresponding vortex centres are initially at the north and south poles; these vortex centres do not remain stationary, but move rapidly along the noon meridian towards B. A *fluctuating* field leads to a sequence of vortices of alternate polarities all moving towards B, two vortices of opposite polarities corresponding to each complete alternation of the field. In the actual ionosphere, the resulting system of current vortices will doubtless be much more complex and irregular than that found from our calculations; but there will be the same tendency for these vortices to move away from the point of lowest conductivity and towards the point of highest conductivity.

It is this tendency which seems to me to explain Sangster's clockwise and anti-clockwise rotations. For, during the afternoon and up to midnight, the point of highest conductivity of the ionosphere would lie in the south-west of Greenwich, and that of lowest conductivity to the south-east. Now it is easily seen that a current vortex in the ionosphere moving southwards approximately along a meridian to the west of Greenwich would cause the disturbance vector at Greenwich to rotate in an anti-clockwise direction through one half-revolution. If this vortex were succeeded by another of opposite polarity, the vector would rotate in the same direction through the remaining half-revolution. Hence a succession of such vortices of alternate polarities would account for the continued rotation of the disturbance vector in the anti-clockwise direction, which is found at Greenwich from 10h. to 24h. At midnight, these conditions would be reversed, and the vector would afterwards rotate in the clockwise direction as observed. The theory indicates a change back to the anti-clockwise direction at noon; Sangster's analysis of the observations makes this change occur at 10h. It is tempting to suggest that this earlier epoch may be due to earth-currents induced in the great stretch of sea to the west of Greenwich, but it is, of course, desirable to investigate the Sangster rotations at other stations before attempting to develop the theory further.

The actual existence of moving current vortices, similar to those assumed in the above explanation, was deduced by Schmidt[2] from an examination of the disturbing force at ten European stations during a period of disturbance at about 18h. on February 28, 1896. The figure given by him (and reproduced in "Geomagnetism", p. 313) shows a current vortex moving southwards along a line to the west of the stations, *followed by another of opposite polarity.* It now appears that these "wandering vortices", as Schmidt called them, may be due merely to self-induction in a *non-uniform* ionosphere. It is perhaps worth emphasizing that, in order to explain the motion of these vortices, it is unnecessary to assume either (1) that there is any mass-motion of the conducting material, or (2) that the currents are produced by some moving primary source of electromotive force. Once the currents are produced (by electromagnetic induction or otherwise) the non-uniform distribution of conductivity in the ionosphere will necessarily cause the current vortices to move in the manner described above.

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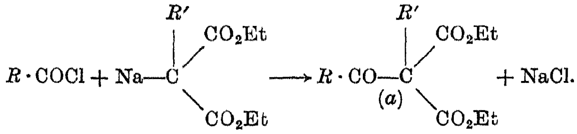
[1] *Proc. Roy. Soc.*, A,, **84**, 85 (1910).

[2] *Met. Z.*, **16**, 385 (1899); see also Chapman and Bartels, "Geomagnetism", 311.

A New Ketone Synthesis

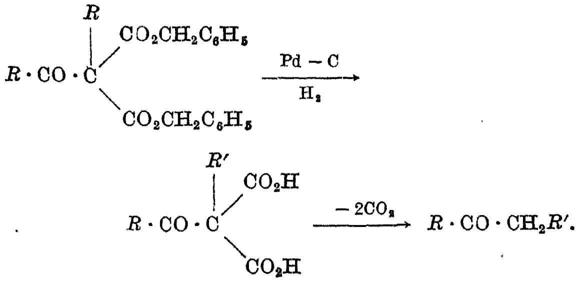
THE reaction between substituted malonic esters and acid chlorides has been investigated on a number of occasions in the past[1], and has been found to give the corresponding acylmalonic esters in high yield according to the following reaction :



$$R\cdot COCl + Na{-}C(R')(CO_2Et)_2 \longrightarrow R\cdot CO{-}\underset{(a)}{C}(R')(CO_2Et)_2 + NaCl.$$

Previous workers[2] have realized the potentialities of such a reaction for the synthesis of ketones of the general formula $R.CO.CH_2R'$, but have failed, except in the case where $R' = H$ [3,4], to effect the ketonic hydrolysis of this type of keto-ester without simultaneous rupture of the bond (*a*).

It has now been found that the benzyl esters of acylmalonic acids readily undergo hydrogenolysis at room temperature in the presence of palladized charcoal with the formation of the parent keto-acids. These acids on gentle warming (50–70° C.) lose two molecules of carbon dioxide and furnish the corresponding ketones in excellent yield.



$$R\cdot CO\cdot C(R)(CO_2CH_2C_6H_5)_2 \xrightarrow[H_2]{Pd-C} R\cdot CO\cdot C(R')(CO_2H)_2 \xrightarrow{-2CO_2} R\cdot CO\cdot CH_2R'.$$

The method is applicable, for example, by suitably modifying the functional groups, to the synthesis of a wide variety of ketones, diketones, keto-acids and other carbonyl compounds. Typical cases in which it has so far been applied are the preparation of heptadecan-8-one (91 per cent yield from *n*-octoyl chloride and dibenzyl *n*-octyl-malonate), 2-methylpentadecan-5-one (80 per cent yield from undecoyl chloride and dibenzyl *iso*butyl-malonate), octacosane-10 : 19-dione (78 per cent yield from sebacyl chloride (1 mol.) and dibenzyl *n*-octyl-malonate (2 mol.)), tridecan-3-one-1-carboxylic acid (more than 66 per cent yield from undecoyl chloride and tribenzyl ethane-1 : 1 : 2-tricarboxylate) and heptadecan-9-one-1-carboxylic acid (81 per cent yield from 8-carbethoxy-*n*-octane-1-carbonyl chloride and dibenzyl *n*-heptyl-malonate, prepared by Mr. R. G. Mason).

The many possibilities opened up by this reaction will be the subject of further investigations, the results of which will be published elsewhere in due course.

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[1] Lang, *Ber.*, **20**, 1326. Michael, *Amer. Chem. J.*, **14**, 510.

[2] Robinson and Robinson, *J. Chem. Soc.*, **127**, 175 (1925).

[3] Walker and Hauser, *J. Amer. Chem. Soc.*, **68**, 1386 (1946).

[4] Bowman, unpublished results.

Extinction of Petrol Fires by Methyl Iodide

IN a recent communication on this subject[1], O. C. de C. Ellis makes a number of statements which should not go unchallenged. First, it is stated that carbon tetrachloride will not extinguish petrol fires. For many years carbon tetrachloride has had world-wide use for the extinction of petrol fires, particularly those associated with internal combustion engines, and its reputation rests to a large extent on its success for this very purpose. Secondly, it does not decompose stoichiometrically to yield twice its vapour volume of chlorine; the amount of chlorine evolved in a fire is, in most cases, negligible[2].

More serious, however, is that several important factors should have been overlooked in the tests and interpretation of results. Carbon tetrachloride and similar materials can extinguish flame only by achieving a sufficiently high concentration in the atmosphere ; clearly, then, volatility is of considerable importance. Methyl iodide (b.pt. 42·3°) will vaporize more readily than carbon tetrachloride (b.pt. 76·7°) ; consequently, there can be apparent differences in the properties of these two substances when they are applied to fires, although modification of technique will achieve the desired result in each case, namely, extinction of the fire. In using carbon tetrachloride it is necessary to provide sufficient heat transfer and, among other ways, this can be simply done by directing the liquid on to a warm surface, when sufficient vaporization takes place to put the fire out. To apply carbon tetrachloride directly into the middle of an inflammable liquid burning in an open tank may, quite likely, not extinguish the fire due to the fact that the carbon tetrachloride penetrates to the cold region underlying the burning surface and so does not vaporize. In any event, large fires of this type should be dealt with by carbon dioxide when the vapours are reasonably confined (as, for example, in a paint tank), or foam when they cannot be so confined.

It is not true that carbon tetrachloride is only one-fifth as effective as methyl iodide; this claim is explained by the fact that the importance of vaporization was ignored and the carbon tetrachloride was used incorrectly. Work carried out some time ago in the laboratories of this Company, to determine the minimum concentration of various substances required to extinguish a standard heptane flame, indicated, indeed, that the descending order of merit is, in general, bromide, iodide, chloride; but the following results show that there is no disproportionate superiority of methyl iodide over carbon tetrachloride.

Compound	Minimum extinguishing concentration (gm. compound/litre of air at N.T.P.)
Methyl bromide	0·19
Methyl iodide	0·28
Carbon tetrachloride	0·33
Methylene iodide	too involatile

The suggestion that pump type extinguishers should be filled with methyl iodide is impracticable. The mechanical problems presented by the use of a volatile liquid like carbon tetrachloride in equipment of this kind have been considerable in the past. If methyl iodide were used these problems would be greatly magnified and, indeed, would be insuperable unless the extinguisher were always kept at a cool and constant temperature. The alternative, therefore, would be the use of a pressurized bottle. Such extinguishers already exist for applications where they are particularly suited, and are filled with carbon tetrachloride or methyl bromide or a mixture of these two.

Judged, therefore, on its usefulness as a fire extinguishing agent, methyl iodide falls between two stools. It is too volatile to be used in a pump type of extinguisher and it would be pointless to consider its use in pressurized bottles on the grounds of improved combustion inhibition, since such appliances already use methyl bromide which is superior in this respect. In fairness it should be said, however, that methyl iodide may have one advantage over methyl bromide in that it may be less toxic.

Concerning the toxicity of methyl iodide, little published information can be found. Garland and Camps[3] report a fatal case of poisoning by methyl iodide in which the symptoms were similar to those of methyl chloride and methyl bromide. Henderson and Haggard[4] say that its toxicity is greater than that of methyl chloride, but less than that of methyl bromide. The same authors rate the toxicities of the latter two substances, relative to carbon tetrachloride, under acute conditions of exposure, as follows: methyl chloride 0·29, carbon tetrachloride 1·00, methyl bromide 2·20. Methyl iodide, therefore, would appear to be of the same order of toxicity as carbon tetrachloride, and it would be rash to assume that it is safer in use without sufficient confirmatory evidence.

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[1] Ellis, O. C. de C., *Nature*, **161**, 402 (1948).

[2] Fieldner and Katz, *J. Franklin Inst.*, **190**, 543 (1920).

[3] Garland, A., and Camps, F. E., *Brit. J. Ind. Med.*, **2**, 209 (1945).

[4] Henderson and Haggard, "Noxious Gases and the Principles of Respiration Influencing their Action" (Reinhold Pub. Corp., New York, 1943).

Influence of Some Anti-Shrink Treatments on the Friction between Wool Fibres

A NEW apparatus has been built for the measurement of the friction between two fibres. The principle is that two fibres are twisted a few turns, and the four fibre ends loaded with equal forces, P_1. The load at one of the ends is increased until slipping occurs. If the necessary force is P_2 and the (small) angle between the fibre ends, β, the coefficient of friction is given by the formula

$$\mu = \frac{\ln P_2/P_1}{\beta\pi n},$$

where n is the number of turns. The apparatus will be described in detail elsewhere[1].

Some measurements were carried out on fibres treated with sodium hypochlorite at pH 1, and on fibres treated with alcoholic potassium hydroxide. The measurements were made on the treated fibres in distilled water, after washing with water or a neutralizing agent. The apparatus is built symmetrically, so that it allows measurements of both with-scale and anti-scale friction on the same fibres. By consecutive measurements the variation in friction with the number of slippings, due to abrasion, could be determined. The same pair of fibres has been used for several series of measurements after different times of treatment. For each series fresh parts of the fibres were introduced in the twist, thus avoiding abraded areas. For untreated fibres, up to 2,500 slippings can be made under the same conditions in the apparatus without any noticeable change in the friction.

Figs. 1 and 2 give the values of the frictional coefficients at different times of treatment and different numbers of slippings. The smaller dots indicate values obtained at consecutive slippings after the given time of treatment.

There is a marked difference in the effects of the two treatments, which are both used for obtaining non-felting wool. Both cause an increase of the frictional coefficients. The chlorination diminishes the difference between the anti-scale and the with-scale friction; but this difference is maintained after the alcoholic potash treatment. A very remarkable difference is the behaviour of the friction after the treatments. The friction of the chlorinated wool is

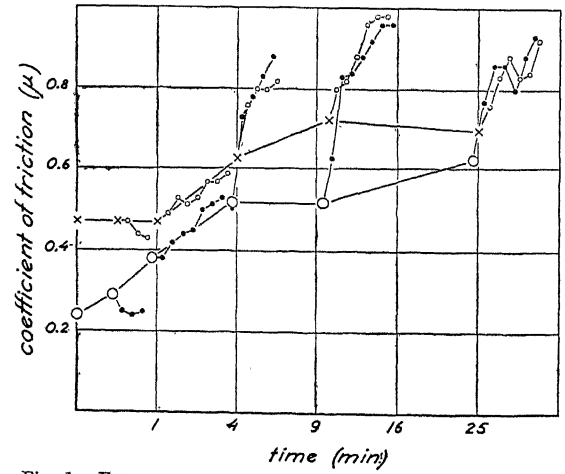

Fig. 1. FRICTIONAL COEFFICIENTS OF WOOL (○, WITH-SCALE; ×, ANTI-SCALE) AFTER TREATMENT WITH HYPOCHLORITE (0·005 PER CENT AVAILABLE CHLORINE) IN 0·1 N SULPHURIC ACID

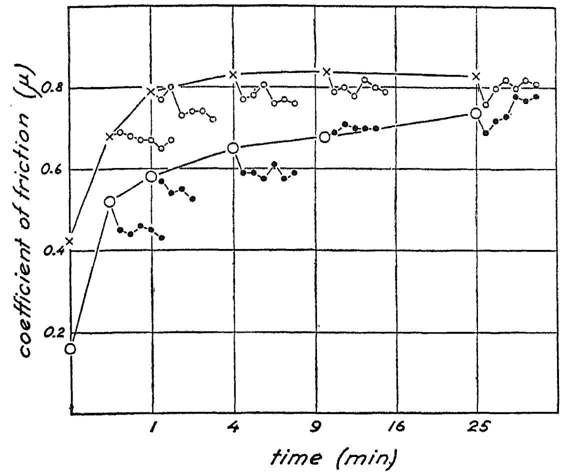

Fig. 2. FRICTIONAL COEFFICIENTS OF WOOL (○, WITH-SCALE; ×, ANTI-SCALE) AFTER TREATMENT WITH 2 PER CENT POTASSIUM HYDROXIDE IN 95 PER CENT ALCOHOL

considerably increased by only a few slippings in the apparatus, and the rubbings of the fibres during measurement eliminate the difference between the anti-scale and the with-scale friction. There is no corresponding effect for the potash-treated wool, where rubbings of the fibres do not noticeably change the friction. All the measurements recorded in the graphs were made in distilled water. Measurements on chlorine-treated wool in soap solutions show a considerable decrease in the frictional coefficients (μ about 0·15); but there is still no difference between anti-scale and with-scale friction. For the potash-treated fibres, the friction in soap solutions is somewhat lower than in distilled water, but there is still a difference between the two coefficients.

It is assumed that the non-felting is caused by the elimination of the difference between anti-scale and with-scale friction. An increase of both coefficients, as with potassium hydroxide treatment, causes a decrease in felting, but not complete elimination[2].

We hope to get more information about the chemical reaction between wool and various non-felting reagents by further studies of the frictional properties.

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[1] Lindberg, J., and Gralén, N., [*Medd. Svenska Textilforskningsinst. Göteborg*, No. 6 (1948)].

[2] Harris, M., and Frishman, D., *Amer. Dyestuff Reporter*, **37**, P52 (1948).

Pharmacology of Some *bis*-Trimethyl Ammonium Compounds

THE curare-like action of a series of *bis*-quaternary ammonium polymethylenes has recently been described by Barlow and Ing[1] and by Paton and Zaimis[1], and we can confirm that the C_3 compound curarizes, but is relatively inactive compared with *d*-tubocurarine chloride on the rat diaphragm (1 per cent). Its action was completely reversed by prostigmine. (Tetramethyl ammonium chloride showed about 2·5 per cent of the activity of *d*-tubocurarine chloride on the rat diaphragm.) The C_5 compound had no action on the rat diaphragm. The C_3 compound has marked cholinergic action—salivation, lachrymation, bradycardia in decerebrated guinea pig—together with relaxation of decerebrate rigidity at a dose of 1·0 mgm. per kgm. It produced a response of the rabbit's ileum similar to that of acetyl choline (potency about 0·1 per cent that of acetyl choline). It has slight activity as an anticholinesterase (rat brain). It has no action on pseudo-cholinesterase (horse serum). Its cholinergic activity, apart from its low curarizing activity, would clearly render it unsuitable as a clinical substitute for *d*-tubocurarine. The C_5 compound has about the same anticholinesterase activity as the C_3.

The overlapping of 'muscarine', 'nicotine', and anticholinesterase activities is a very striking phenomenon which constantly recurs in complex quaternary ammonium compounds. If the chain includes phenyl groups the effect of increasing the distance between the $\overset{+}{N}$ atoms is not to increase the curarizing activity, but to develop anticholinesterase activity. $\overset{+}{N}(CH_3)_3.C_6H_4.CH_2.C_6H_4.\overset{+}{N}(CH_3)_3.2I$, in which the distance between the quaternary nitrogens is a little less than that of the C_7 *bis*alkyl ammonium, is about 6 per cent of the activity of *d*-tubocurarine on the rat diaphragm, and shows 'muscarine' effects but is not an anticholinesterase. If four more CH_2 groups are inserted into the chain, the curarizing activity drops to 2 per cent, but the compound is a very active anticholinesterase—of the same order of activity as eserine. Clearly the nature of the chain, as well as the distance apart of the $\overset{+}{N}$ atoms, affects considerably the activity of the compound.

We have attempted to determine the distance between the nitrogen atoms in Fisher–Hirschfelder models of the tubocurarine ion. Unfortunately, at least seven possible configurations can be constructed, any one of which might represent *d*- or *l*-tubocurarine, or *d*- or *l*-curine, and no one of which is convertible into another without breaking one bond or another. The distance apart of the nitrogen atoms varies for different models from that corresponding to C_3 to that corresponding to C_8 straight chains.

With regard to the species variation, remarked on by Barlow and Ing, and Paton and Zaimis, we showed in July 1947, at the Pharmacological Society, some results with two closely related compounds—*d*-tubocurarine and its dimethyl ether.

The ratio of the potency of the dimethyl ether to *d*-tubocurarine is:

	Intact animal	Diaphragm
Rabbit	9	3
Rat	3	3
Guinea pig	2	1
Albino mouse	0·5	0·4

Not only does the ratio vary between different species, but also especially in the rabbit the discrepancy may be larger in the intact animal.

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[1] *Nature*, **161**, 718 (1948).

Incidence of Malaria in Tropical Africa

The conventional 'parasite-rate' (percentage proportion of children aged 3–10 years in whose blood malaria parasites are detected by a single examination) may be a misleading standard of qualitative measurement giving a distorted idea of the amount of malaria in a locality. But in practice a reduction from 70 to 40 per cent is often claimed to be evidence of effective malaria control, and we are led to believe that a figure of 5 per cent is a splendid achievement indicating a very low malaria incidence.

It has been pointed out that the rate at which infants acquire their first infection offers an exact and quantitative alternative method of measurement. If we can find the number of *infective mosquito bites* received by people in a given time, we have in a single figure not only the malaria-transmitting ability of the mosquitoes but also the actual incidence of the disease itself[1].

Working in Freetown, West Africa, we investigated the blood of infants at monthly intervals, and the examinations of fifty individuals made sequentially for eighteen months showed that twelve infections were received during that time. We could say that mosquitoes were infecting one in six infants each year.

Now if we visualize a situation in which one in every six persons in a city in the British Isles were to be infected with malaria each year, the problem of dealing with some 13,000 cases among a population of 80,000 such as existed in Freetown would indeed be a formidable one ! (We are not, however, necessarily inferring that the African may react to infection as severely as the European.) Yet when we came to express the number of examinations of infants in whom malaria parasites were detectable as a percentage of the total examinations made, a parasite-rate of 5 per cent was obtained. On the face of it, that is a very small figure and could have easily misled us into a false assumption that the malaria incidence was very low.

Now while the infants were being investigated, mosquitoes were collected from houses in Freetown by standard methods, and the proportion carrying salivary gland infections was measured. From this data it was possible to calculate the 'parasite-rate' of the infants. The accuracy of these estimates encouraged us to calculate theoretical 'parasite-rates' produced by a wide range of numbers of 'infective mosquito bites' received by the average child in a year (see table). These values were in close agreement with observed data.

Number of infective mosquito bites per child per year	0·01	0·1	0·2	0·4	1·0	2·0	5	10	50
Calculated parasite-rate % in children	0·26	2·6	5·0	10	23	40	73	92·5	99·9

A reduction of the parasite-rate to 40 from 70 per cent then merely represents the difference between the average child receiving two infections of malaria each year and five. A parasite-rate of 2·5 per cent is revealed as the result of infection of one in ten children each year, which is certainly still too high.

Yet after four years of the most intensive mosquito control in Freetown, it appears that the parasite-rate of school children could not be reduced below a figure of 10 per cent (we can stop mosquitoes breeding but not people moving into and out of our control area). While that is a very low rate for tropical Africa, our investigation suggests that infections are still received by no less than half the children each year.

We feel that were it possible to achieve a situation where one in a thousand persons contract the disease per year, then we might be entitled to say that control of malaria could be effected. But over nearly all tropical Africa the average African seems normally to receive not less than five and frequently many more than fifty infective mosquito bites each year.

Above a figure of 75 per cent the parasite-rate has no practical significance, since the average person is receiving superfluous infections. At satisfactory numbers of infective mosquito bites per year, the parasite-rate is less than 1·0 per cent. Consequently, changes in intervening values have also little practical meaning.

If this be the case, most efforts at malaria control may merely reduce the frequency of receiving infection at the cost of partial loss of immunity without necessarily leading to any appreciable reduction of the disease.

It all depends upon whether we are concerned in protecting small groups of completely non-immune Europeans, or attempting to protect the otherwise immune or partially immune indigenous population. If the latter, it may well be that we shall have to revise our conventional methods of assessing the incidence of malaria, and attempt to discover just how often the *average* African is, in fact, infected and what exactly are the effects of malaria upon his health and efficiency.

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[1] *Ann. Trop. Med. Parasit.*, **41**, 380.

Inhibition of Aerobic Sporing Bacilli by Hæmatin

Certain bacilli will not grow on nutrient agar containing hæmatin at a concentration of 1/20,000. Other bacilli do not appear to be affected by hæmatin. The organisms tested are shown in the following table, the figures in brackets being the number of strains of each species tested.

Inhibited by Hæmatin	Not inhibited by hæmatin
Bacillus brevis (5)	*Bacillus anthracis* (2)
,, *licheniformis* (11)	,, *carotarum* (2)
,, *megatherium* (10)	,, *cereus* (11)
,, *subtilis* (45)	,, *circulans* (7)
	,, *firmus* (11)
	,, *fusiformis* (5)
	,, *laterosporus* (1)
,, *alvei* (1)	,, *alvei* (2)
,, *coagulans* (1)	,, *coagulans* (2)

With the exceptions of *B. alvei* and *B. coagulans*, all the tested strains of a given species reacted uniformly towards hæmatin. The growth of *B. subtilis* was completely inhibited by hæmatin at a concentration of 1/125,000, and was partially inhibited by hæmatin at a concentration of 1/500,000.

The effect of hæmatin on a wide range of other species of bacteria was tested; but in no case was inhibition observed, with the possible exception of some *Corynebacteria*. At a concentration of 1/16,000 hæmatin appeared partially to inhibit the growth of a few strains of *Corynebacterium diphtheriæ mitis* and *gravis*, *C. hofmanni*, *C. xerosis* and a gelatin-liquefying diphtheroid. On the other hand, it strongly stimulated the growth of two strains of starch-fermenting, gelatin-liquefying *Corynebacteria*.

Hæmatoporphyrin and coproporphyrin III at concentrations of 1/20,000 did not appear to inhibit the growth of *B. anthracis*, *B. brevis*, *B. cereus*, *B. licheniformis*, *B. megatherium* or *B. subtilis*. Mesoporphyrin, 1/20,000, did not inhibit the growth of *B. anthracis*, *B. cereus* or *B. subtilis*, but it appeared partially to inhibit the growth of *B. brevis*, *B. licheniformis* and *B. megatherium*.

None of the organisms referred to above was inhibited by whole or laked red blood cells, with the exception of six of the forty-five strains of *B. subtilis* tested. These six particular strains grew quite readily on nutrient blood agar, but the cultures autolysed within seventeen hours of inoculation; they did not autolyse for at least three days when blood was omitted from the same nutrient agar. With the exception of *B. megatherium*, all the strains of organisms which were inhibited by hæmatin were also inhibited by laked red blood cells plus trypsin; they were not inhibited by whole red blood cells plus trypsin, even when they were able to hæmolyse the red cells.

Prof. C. Rimington (who kindly supplied me with the porphyrin derivatives I have tested) has reminded me that Kämmerer[1] claimed more than thirty years ago that hæmatin (1/2,000) did not inhibit any of the organisms he had tested, including (what was then called) *B. subtilis*, but that mesohæmatin inhibited the growth of a large number of Gram-positive organisms, including *B. anthracis*.

I am indebted to Miss Kathleen Gilliver of this laboratory for supplying cultures of the bacilli which I used, and for advice concerning them.

This work is being continued.

W. E. VAN HEYNINGEN
Sir William Dunn School of Pathology,
University of Oxford.
April 9.

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[1] Kämmerer, H., *Verhandl. d. deutschen Kongresses f. inn. Med.*, **31**, 704 (1914).

Effects of Aeration on Bracken and Heather Grown in Nutrient Solution

It has frequently been noted by ecologists, and is readily observed in the field, that the bracken fern (*Pteridium aquilinum*, Kuhn.) is halted in its advance on encountering water-logged soil. Also, irrigation of a *Pteridietum* rapidly decreases the density and height of the plant. Apparently no experimental investigation of aeration as a factor in the growth of bracken has hitherto been made. Watt has suggested that aeration may be an important factor in the outcome of the struggle between bracken and heather (*Calluna vulgaris*, Salisb.), and therefore the latter has been the subject of similar experiments.

Solitary bracken sporelings bearing a few small fronds and roots were placed in jars containing a variant of Knop's solution. One series of eight jars was aerated continuously for two months. A second series was left unaerated, and nitrogen from a cylinder bubbled through a further eight cultures.

Calluna seedlings were grown under similar conditions except that each series consisted of twelve jars and the medium used was half-strength Crone's solution, periodically adjusted by addition of dilute sulphuric acid to maintain the *p*H of the solution below 6.

Estimations of dissolved oxygen were made by the Winkler method adapted for small samples in a syringe pipette.

The results of these experiments are summarized in the accompanying table.

The roots of the bracken plants in aerated cultures were long with many branches, of a golden-yellow colour, and the tips of the main roots and laterals were noticeably swollen.

In the unaerated series, the roots were short and bunched, and in no case did the roots penetrate more than a centimetre or so beneath the surface of the solution. The roots were dark-brown in colour. No lateral branching occurred and swollen root tips were not found.

The plants treated with nitrogen were older than the others. One might have thought that their greater size would have rendered them more vulnerable to the effects of low oxygen supply. Nevertheless, even after two months of almost continuous passage of nitrogen, the health of the plants was but slightly impaired, as indicated by a wilting of some fronds to a small extent. The mean root-length was somewhat lower than in the unaerated series. The rhizomes of most plants in the series bore many short adventitious roots along their length and, in certain cases, these were developed to such an extent as to produce a network in the damp cotton wool and on the surface of the cork. This may be interpreted as a response whereby the young plants were able to absorb oxygen from the air when grown in solution containing little oxygen.

At harvesting, the aerated heather plants, while apparently healthy, were of smaller stature than the unaerated ones. The root systems tended to be bunched, and, although much branching occurred, the laterals were very short in most cases. Microscopical examination of the aerated roots showed that the mycorrhizal fungus had very few external hyphæ. In the cortical cells, the mycelium was never so dense as to fill the cells completely.

In unaerated solutions, both root- and shoot-growths of heather were luxuriant. Mycorrhizal development was little different from that in the aerated plants.

	Pteridium aquilinum			*Calluna vulgaris*		
	Aerated	Unaerated	Nitrogen	Aerated	Unaerated	Nitrogen
Mean temp. of sol. (deg. C.)	11·3	—	—	15·7	17·4	17·9
Mean dissolved oxygen (c.c./litre at N.T.P.)	7·71	6·293	1·191	7·053	5·153	2·616
Mean lengths of roots (cm.)	22·6	6·7	6·2	8·1	15·3	8·2
Mean dry weight of roots (gm.)	0·0815	0·0595	0·0922	0·0894	0·0960	0·0717
Mean dry weight of fronds (gm.)	0·1475	0·0648	0·1573	0·2586	0·3561	0·2412
Ratio of roots to fronds (mean dry weight)	1 : 1·8	1 : 1·1	1 : 1·7	1 : 3	1 : 3·7	1 : 3·4

With almost continuous treatment with nitrogen, root- and shoot-growths were approximately the same as with air. External hyphæ were more frequent and the mycelium in the root cells was often in an advanced stage of digestion.

Work on the respiration-rates of the roots in relation to oxygen supply, and on the precise oxygen concentrations in various bracken and heather soils, is being carried out.

L. W. POEL

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March 10.

Etiology of Grass Disease

IN view of the letter in *Nature* of May 22 in which W. S. Ferguson recorded a paralysing action of grass juice on the isolated rabbit intestine, it may be of interest to note that we have succeeded, by ligature of the ileum in experimental ponies, in reproducing the main clinical, biochemical and post-mortem findings of acute grass disease. Although in this disease there is no obvious obstruction to the onward passage of fluid from the greatly distended small intestine to the dehydrated contents of the colon, the close similarity between experimental ileal obstruction and the naturally occurring condition suggests that in the latter there may be some functional upset in this region. As the large majority of cases occur in horses at grass, and as the peak incidence occurs during the active-growth stage of the herbage, it is tempting to suggest that the disturbance may be due to some chemical substance either existing preformed in the grass or produced in the process of digestion. Ferguson's observations would seem to be well worth following up with this possibility in mind.

A. ROBERTSON
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Apus and a Rare Cladoceran in Britain

THE primitive crustacean known as apus, or *Triops cancriformis* (Bosc), which is of particular interest to zoologists, has only been recorded five times in Britain. It was found in 1738 in Kent[1], at the beginning of last century near Christchurch in Hampshire[2], a little later at Bristol[3], in 1907 in Kirkcudbrightshire[4], and in 1934 near Fordingbridge in Hampshire[5]. Last summer, at the suggestion of Prof. J. Omer-Cooper, one of the discoverers of apus near Fordingbridge, I sought it and got it again from the same pool in which it occurred in 1934 [6]. It seems, then, as if apus were a permanent inhabitant of Britain and not merely introduced from time to time through its drought-resistant eggs being carried in mud on birds' feet. I am submitting a full account of my find for publication in the *Proceedings of the Zoological Society*. Apus may not be quite so rare in Britain as the recorded finds suggest, for Ray Lankester, in letters to Dr. W. T. Calman and Dr. R. Gurney, related that he found it on Blackheath and in Worcestershire. I should welcome news of other finds. The habitat in Hampshire is a shallow grass-bottomed pool which is waterless in dry weather.

In 1946, Mr. D. J. Scourfield described a new species of *Daphnia* from Kew Gardens, *D. ambigua*[7]. From the locality in which he found it, Mr. Scourfield suggested that it had been introduced with aquatic plants from abroad. Last summer, and again this summer, I have found *D. ambigua* Scourfield to be abundant in Regent's Park lake. This need not invalidate the hypothesis of a foreign origin, since *D. ambigua* may have been introduced into the lake, in the form of ephippia by birds, from the old Botanic Gardens near by. It was there that the first freshwater medusa was discovered in 1880, in a tank with the water lily *Victoria regia*, coming, therefore, perhaps from South America. Again, I should like to hear of other finds of *D. ambigua*.

H. MUNRO FOX

Bedford College,
University, London.
June 28.

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[1] Brown, L., *Phil. Trans. Roy. Soc.*, **40**, 153 (1738).

[2] Leach, W. E., Supp. to 4th, 5th and 6th editions "Encyclopædia Britannica" (1816).

[3] Clayfield, W., specimens in British Museum (Nat. Hist.).

[4] Balfour-Browne, F., see Gurney, R., *Nature*, **76**, 589 (1907).

[5] Hobson, A. D., and Omer-Cooper, J., *Nature*, **135**, 792 (1935).

[6] Fox, H. M., *Agenda Sci. Meet. Zool. Soc. Lond.*, No. 2 (1948).

[7] Scourfield, D. J., *J. Quekett Micr. Club*, (4), **2**, 127 (1946).

Re-discovery of *Apus cancriformis*

IN September 1907 I discovered two shallow grassy pools on the Preston sea merse, near Southwick, Kirkcudbrightshire, in which *Apus* was present. In one of these it was so abundant that when I raised my eleven-inch ring net out of the water it was half full of specimens, mostly full-grown. I searched many other pools in the same area but without finding it and, returning to the same pools a few days later, I found the edges covered with the shells and very few specimens left in the water. The gulls had discovered this mass of food and had destroyed most of the *Apus*. I have visited the area many times during the last forty years but not until this month, working the merse near the mouth of the Southwick burn, have I again seen *Apus*. My son found three specimens in a pool which then yielded us about thirty or more, and several other pools near the first produced small numbers, mostly immature.

Geoffrey Smith[1] remarked upon the erratic way in which the Phyllopods are scattered through the regions they inhabit, and how they may appear in a pond for several seasons and then vanish. While *Apus* occurred in different parts of Britain on each of the few occasions of which we have records, the accepted explanation of its appearance seems to have been that it was brought each time on the feet of geese and other aquatic birds ; but when it turns up after forty years within a mile or two of where it was originally found, it is perhaps reasonable to ask, has it been present in the hundreds of pools in the sea merse which extends, with gaps, from Southwick via Ruthwell, Powfoot, etc., and into Cumberland ?

FRANK BALFOUR-BROWNE

Brocklehirst,
Collin,
Dumfries.
June 29.

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[1] "Cambridge Natural History", 4, 34 (Macmillan).

ENGINEERING RESEARCH AT CAMBRIDGE

THE report of the head of the Department of Engineering, University of Cambridge, on the work of his Department for the year 1946–47, was published in the *University Reporter* of April 27.

The report is divided into three sections under the headings teaching, research and workshops. The first section is of interest because it deals with the transition period when some men were reading for the old undivided Mechanical Sciences Tripos, held for the last time in 1947, and others for the new two-part Tripos which was held for the first time in that year. The new Part 2 course, in spite of starting under difficult conditions due to heavy numbers and shortage of staff, ran surprisingly smoothly. In all, 265 candidates sat for Tripos examinations in 1947. The report points out that while the number of undergraduates in the Department (658) was 117 less than the average in 1920–21, the corresponding year after the First World War, no less than 574 of them were reading for honours as compared with 447 in 1920–21. The difference in research activity is even more marked; during 1946–47, in addition to the members of the teaching staff, 23 postgraduate students were engaged in research work as compared with 3 in 1920–21.

In its second section the report deals briefly with some thirty-five projects being carried out in nine laboratories of the Department. In aeronautics the study has been begun of the behaviour of air as it flows past a solid porous surface through which some of the air is sucked, and theoretical work was continued on the prediction of aerodynamic reactions on wings when account is taken of the boundary layers which form on their surfaces. Other investigations involving fluid motion, carried out in the Hydraulics Laboratory, included the protection of a pumping main by admitting air through a valve as an alternative to the air-bottle method, the actions of whirlpools, a theoretical investigation giving an approximate method of dealing with the equations governing the oscillations in a surge tank fitted to a pipe line, and the instability of a fluid surface when accelerated in a direction normal to its plane.

The main effort in the Electrical Laboratory was centred on re-equipment and on setting up a Magnetic Laboratory, but five main projects in electronics were undertaken, namely, the construction of an automatic plotter for trajectories in an axially symmetric electrostatic system, the construction of a new type of mass spectrograph, the investigation of the modulation of an electron beam, and also of shot noise in thermionic valves, and the construction of an experimental electrostatic electron microscope.

In the Heat Engines Laboratory, new methods have been used to examine the scavenging process in a two-stroke engine. An investigation, supported by the Motor Industries Research Association, was also embarked upon to record the movement of a piston ring relative to its groove in an engine running under its own power. Other projects, supported by the Ministry of Supply, concerned gas turbine problems, including the investigation of the flow through cascades of axial-flow compressor blades, and a study of the turbulent boundary layer break-away of air from the flat boundary surface of diffusers and from the curved surfaces of blades. Work was also begun on the heat-flow characteristics of liquid metals and on the development of a magnetic pump for pumping a liquid metal.

Considerable work was in hand in the Materials Laboratory. Since 1943 a team of workers, supported by the Admiralty, has been investigating the causes of fracture in welded ships. It has been shown that while residual stresses and reaction forces can be high, neither is the chief cause of fractures in welded ships; the trouble can, however, be attributed to a property of mild steel known as 'notch brittleness'. Two other investigations aimed at determining the effects of high rates of strain on mild steel and the effects of low rates on aluminium and other materials. A third was concerned with distribution of stress and strain in real materials having non-Hookean properties.

In the Mechanics Laboratory, the solution has been obtained to the problem of the stresses caused by a suddenly applied load on a beam supported in various ways; a number of direct verifications of the theoretical predictions of stress have been obtained experimentally. An investigation, supported by the London, Midland and Scottish Railway Company, of the motion of a single railway axle and a pair of wheels was completed. A special photo-elastic bench equipped with stroboscopic light sources has been constructed, with the help of a grant from the Institution of Mechanical Engineers, for the determination of the dynamic stresses in gear teeth. An attempt, assisted by the British Iron and Steel Research Association, is being made to determine theoretically and experimentally the relative distribution of useful and frictional work in the wire-drawing process.

A number of problems relating to pressure vessels have been investigated. Methods were devised for the solution of the differential equation governing the stresses and deflexions in drumheads of any rotationally symmetrical form with the aid of a mechanical analogue apparatus; help with this project has been given by the Research Department of Messrs. Babcock and Wilcox. Tests, supported by the British Welding Research Association, have been made on the pipe-bend portions of welded pipe lines, and it has been shown that the greatest surface strain occurring in the cross-section is the transverse strain inside.

With the support of the Nuffield Foundation, a start was made on the problem of tillage by measuring the component soil forces on a simple implement in motion.

In addition to the work on brittle fracture, the Department has been collaborating in other investigations on ships. Full-scale trials were conducted by the Admiralty during the years 1945–47, and the work being carried out in the Department is the reduction of the experimental data to a form suitable for interpretation into practical design recommendations. Work similar in aim though very different in scale has been undertaken on a 14-ft. sailing boat.

Much research into the behaviour of other structures was carried out. An investigation, supported by the British Welding Research Association and the Department of Scientific and Industrial Research, to find the true load-carrying capacity of rigidly jointed steel frame structures was continued. The behaviour up to collapse of a length of continuous stanchion bent in double curvature was investigated experimentally and a theoretical analysis of the same problem was completed. A successful start in developing a method of design taking account of plastic deformations was made by dealing with single-bay rectangular portal frames; the lateral instability of steel beams bent until they had partially yielded was studied, and a considerable programme of tests on battened struts was carried out.

In addition to these investigations under static loading conditions, attention has been given to the fatigue strength of structures. Equipment was developed successfully for carrying out fatigue tests on full-scale structures and structural components by the resonance vibration method.

A comprehensive investigation into the behaviour of light alloy struts was made, and an experimental and theoretical study of the lateral instability of light alloy beams is also being undertaken with the help of the Aluminium Development Association.

RABELAIS ON SYPHILIS

In a thesis for a doctorate in medicine at the University of Paris, Dr. Mottron has chosen to extract from the books of Gargantua and Pantagruel all the references to syphilis ("Rabelais et la Verole". By J. Mottron. Pp. 127. Tours: Arrault et Cie., 1947). The texts are quoted *in extenso* and the commentary thereon gives a study of syphilis as it was understood in the first half of the sixteenth century.

Rabelais was a contemporary of Fracastorius, but he did not use the term syphilis, which only became popular much later. In the prologue to Gargantua, Rabelais dedicates his writings to "Buveurs tres-illustres, et vous verolez tresprecieux". His references to the disease are all in terms that could be understood by his lay readers.

The epidemic of syphilis in Europe began in 1493, and when Rabelais was writing there was already a good descriptive knowledge of the disease. The chancre was recognized as the primary focus of infection and its characteristic induration had been described. Also known were the short latent period before the start of the secondary stage with its *croustelevés*, or rupial lesions, and all the other manifestations of secondary syphilis on the skin and in the nervous system.

It was fortunate that mercury, the only useful remedy of the times, was used almost at once, and by accident, in the treatment of the new disease and that its good effects were recognized. Mercury was first used by inunction, and there is an allusion to this method of treatment in Rabelais' prologue to the books of Pantagruel. The toxic effects of mercury are also mentioned. When mercury was shown to affect syphilis the dosage was increased to toxic levels, and the ill-effects were confused with the manifestations of the disease itself. This confusion resulted in the change to guaiacum which, for a short period, superseded mercury.

Although mercury was used orally as early as 1533, inunction long continued as the chief mode of application. Sweating baths were often associated with mercury inunctions. Gasparo Torrella (1497) recommends the "best way to treat syphilis is to sweat the patient for fifteen days, fasting, in a steam bath or oven". Jean Fernel (1557) writes of steam baths at high temperature for twenty days or more. Sarsaparilla, a sudorific agent used in conjunction with baths, is also mentioned by Rabelais. The vogue for sweating has continued ever since. Baths in mercury vapour were used by Langston Parker in 1850 and to-day we use more elaborate methods in the hypertherms. Rabelais seems to have intended his works to be read by the suffering *verolez* while they were sweating. It is doubtful whether even Rabelais could mitigate the sufferings of the modern sweating cabinet; but it is an idea which ought to be tried.

Dr. Mottron seems to favour the theory that syphilis existed in Europe in the pre-Columbian era and that the disease was unrecognized before 1493, or confused with leprosy, scabies, etc. He cites Broca's (1876) observation of the discovery of syphilitic lesions in bones from an ancient leprosorium, and quotes the monk Theodoric (thirteenth century), Gaddesden (fourteenth century) and Bernard Gordon (1305) on the transmission of 'leprosy' by sexual intercourse.

The evidence of contemporary observers such as Torrella and Ulrich von Hütten is, however, of a new, hitherto unknown disease which alarmed the doctors to the point where they fled from the presence of the sick. Public health measures were quickly enacted all over Europe. In Paris, in 1497, foreigners with the great pox were warned to leave the city under pain of the halter for disobedience, and citizens so affected had to stay always indoors. The next year, 1498, the penalty for the unfortunate syphilitic discovered at large in Paris was to be thrown into the river. In the city of Aberdeen, at the same time, to combat the French disease, it was ordained "that all licht weman be chargit and ordanit to decist fra their vicis and syne of venerie, and all their bothis and housais skalit". All these evidences suggest something absolutely new and terrifying.

In favour of the American origin for syphilis are many points unspecified by Dr. Mottron. He does not mention, for example, Ruy Diaz de Isla's "Tractado Contra el Mal Serpentina", in which is described the treatment, at Barcelona, of some of Columbus's men on their return from Haiti. Nor does he allude to more recent investigations on ancient bones which seem to show that syphilitic osteitis did not occur in Europe or Egypt before the sixteenth century. This controversy is, however, interminable and can be closed for the present with the observation that Rabelais talks of a case of the *verole* in 1420.

The entity of syphilis is recognized by Rabelais. He mentions gonorrhœa only rarely, but it is quite clear that he knew it as a separate disease. Syphilis was also distinguished from leprosy in Rabelais' day. Vibert speaks of lepers fearing contamination from syphilitics. Rabelais knew syphilis to be a contagious and venereal disease; but he does not seek, like some of his contemporaries, for causes in planetary disturbances, poisoned water, cannibalism, etc.

Dr. Mottron ascribes to Rabelais the tract "Triomphe de Très Haute et Puissante Dame Vérole". In this is cited, perhaps for the first time, a cause for venereal disease which is still occasionally suggested by patients:

> "Et notre fiffre a uriné
> Contre un mur dont mal lui en print".

Dr. Mottron is to be congratulated on his scholarly development of a very interesting theme. My only criticism is of his rather one-sided treatment of the theory of the American origin of syphilis; but as Rabelais is on his side I shall say no more.

JAMES MARSHALL

STRESS ANALYSIS AND THE DESIGNER

A DISCUSSION on "Stress Analysis and the Designer" was opened by Sir Donald Bailey at the Birmingham Conference on April 13 of the Stress Analysis Group of the Institute of Physics. Sir Donald outlined his attitude to stress analysis as an engineering designer. He needed answers to particular problems which could not be obtained by mathematical methods either because of the complexity of the mathematical solutions or because of design assumptions, unknown boundary conditions or other practical uncertainties. He specified his requirements as the need to measure stresses up to 75–85 tons per sq. in. in steel or 25–30 tons per sq. in. in light alloys, occurring at frequencies from 0 to 25 cycles per second in structural work and up to 50 cycles per second in mechanical work. This required recording apparatus that would respond to at least 1,000 cycles per second. The stresses obtained should be correct to within 2½–5 per cent for all stresses from 4 tons per sq. in. upwards.

Sir Donald outlined the field conditions under which he required his apparatus to operate. On structural work he found that he had very often to carry out tests in bad weather and on remote sites devoid of a power supply. The structures under investigation were often large and the readings had to be available at a central recording station several hundred feet away from the structure. Experts on strain gauge methods were not usually available, and the equipment used had therefore to be sufficiently reliable to be operated by the practising engineer, who was not generally competent to carry out repairs to electronic equipment if this went out of commission at the crucial moment during a test.

The shortcomings of a number of methods of experimental stress analysis were then discussed. Mechanical and optical strain gauges are generally unsuitable for use in the field because they are incapable of recording localized and dynamic stresses and cannot be adapted for central recording of the readings from a large number of gauges. Sir Donald has found acoustic gauges to be unsatisfactory and too large and heavy for his purposes. Brittle lacquer techniques and photo-elastic methods were mentioned in passing, but neither of these are field methods. The rigid temperature control required for the brittle lacquer methods rules these out for use in the field; photo-elastic methods are extremely useful, but necessarily limited to laboratory investigations on small-scale models.

The electric resistance strain gauge is the most widely used method, but Sir Donald Bailey felt that much more development work is needed here; the sticking of the gauges to the structure needs much skill and experience in order to give consistent results. The waterproofing of gauges in the open air has been found difficult. Temperature control and the correct wiring of large numbers of gauges have been found awkward and time-consuming, and the equipment used in the recording of dynamic stresses has not, in general, been found very reliable.

During the discussion which followed, the use of the acoustic strain gauges, particularly those of the Maihak type, was defended; and a number of speakers felt that by virtue of their robustness and freedom from troubles due to changes of temperature, these gauges were eminently suitable for use in static tests of large structures.

A number of speakers felt that the difficulties of mounting electric resistance strain gauges have been exaggerated, but there was general agreement that the waterproofing of gauges in exposed positions is of paramount importance. The general feeling of the meeting was that there is no alternative to soldering the leads to electric resistance strain gauges; plugs and sockets invariably lead to erratic results. Where immediate results are required in the field, the use of pen-and-ink recorders was advocated; a representative of Messrs. Kodak pointed out that immediate results are obtainable from ordinary film and that processing in special solutions in a mobile unit need only take 40 seconds.

There was very general support for Sir Donald Bailey's contention that the manufacturers of electronic devices might pay more attention to the reliability of their products. The point was made that the engineer engaged on stress analysis work should be able to feel the same confidence in his oscillographs, amplifiers and other electrical recording equipment as the average householder has in his domestic wireless set. The view was put forward very strongly that the manufacturers tend to think of their customers too often as experts in electronics, who use the equipment in laboratories where minor repairs can easily be carried out, and do not cater for the engineer who wants to use his electronic gear merely as a tool and who knows no more about the construction of the instruments than is necessary for their efficient use. One industrial research unit was quoted as an example of the waste of effort involved in the present position; in this unit no less than nine members of the staff out of a total of thirty are engaged in the instrument section dealing mostly with breakdowns and troubles caused by insufficient screening of electrical recording instruments. It was made very clear by the discussion that the manufacturers have a long way to go before they achieve a standard of reliability and robustness in their products which will satisfy their customers in the growing field of experimental stress analysis.

E. K. FRANKL

INTERNATIONAL INSTITUTE OF WELDING

WELDING has just achieved organisation on an international scale by the formation of the International Institute of Welding, at a meeting in Brussels during June 8–11, attended by the representatives of fourteen countries.

At the meeting of the Governing Council on June 11, M. P. Goldschmidt, administrative director of the Belgian Institute of Welding, was elected the first president of the International Institute, and the Council elected as vice-presidents Prof. H. E. Jaeger, lecturer in naval architecture at the University of Delft, and Prof. A. Portevin, president of the French Institute of Welding. One other vice-president is to be nominated by the American Welding Society. Mr. Walter Edström, vice-president of the Swedish Welding Committee, was elected treasurer. A special responsibility has fallen to the British welding community through the election as the first secretary-general of the international body of Mr. G. Parsloe, secretary of the British Institute of Welding.

The primary business of the meeting was to establish the International Institute and to set up a number of special commissions on various technical subjects. The following subjects have been included, the names of the respective chairmen being given in brackets: gas welding (M. C. G. Keel, director of the Swiss Acetylene Society); electric arc welding (Prof. H. E. Jaeger); resistance welding (chairman to be nominated by the U.S. National Resistance Welding Association); documentation (M. A. Leroy, director of the French Institute of Welding); testing and measurement (M. P. Goldschmidt); preparation of a welding dictionary (chairman to be nominated by the Belgian Institute of Welding); hygiene and safety (Mr. A. Härlin, secretary of the Swedish Welding Committee); weldability (Prof. Jaeger); residual stresses (Dr. F. A. Fox, assistant director of the British Welding Research Association); mechanical stress relieving (Prof. W. Soete, technical adviser to the Belgian Institute of Welding and lecturer at the University of Ghent); brittle fracture (Mr. Scheil, of the A. O. Smith Corporation, Milwaukee)

On June 8 and 9, two sessions were devoted to the reading of technical papers, and works visits were arranged on the following day.

It is intended to hold a similar expanded meeting of the Governing Council annually, and an invitation from the Netherlands to meet there in 1949 has been accepted. An invitation from the British delegation to hold the first World Welding Congress in Great Britain in the British Festival year, 1951, was also accepted.

TOXICITY OF D.D.T.

THE insecticide most in the public mind to-day is that known as D.D.T., concerning the efficacy of which rather extravagant claims have been put forward. Nevertheless, its discovery has already proved an event of major importance in view of its cheapness, adaptability and wide range of application. There remain, however, many aspects needing detailed study. One of these is the toxicity of D.D.T. to man and animals, both in the tropics and in temperate regions.

This subject has been investigated by Surgeon-Lieut. F. M. G. Stammers and Lieut.-Commander F. G. Sarel Whitfield, senior entomologist to the Medical Director General of the Navy. A brief summary of the investigations appeared in *Nature*, **157**, 658 (1946); the full account has been published in the *Bulletin of Entomological Research* (**38**, 1; 1947). In the course of the investigations fifteen men, attached to the Royal Naval School of Tropical Hygiene in Colombo, were adopted as subjects for inquiry. They had been exposed for many months to heavy and continuous daily contact with a 5 per cent solution of D.D.T. in kerosene. Their work consisted of spraying ships and shore establishments against infestation by various insects. Of the men employed, one was a Tamil and the remainder Cinghalese. The results of a detailed medical investigation of these men, together with their general demeanour and labour output, indicated that they had received no ill-effects. In England the toxicity of a continuous-phase aerosol of D.D.T. to man and animals was investigated by means of trials at the Royal Naval Hospital, Plymouth, and at the Chemical Defence Experimental Station, Porton.

In so far as human beings were concerned the results were entirely negative. Also, there were no symptoms of D.D.T. poisoning in rats and rabbits as the result of 28-days exposure to continuous D.D.T. aerosol. Messrs. Stammers and Whitfield devote most of their paper to a critical review of the literature on the subject under investigation. As the result of this study and of their own investigations, it seems that D.D.T. is harmless to man and animals when used as an insecticide. It is, nevertheless, possible by unskilled formulation, by the use of unsuitable solvents and by misapplication to incur risk of life. The chance of cumulative effects from the storage of D.D.T. in the milk and tissues of sheep and cattle needs further investigation.

INSTITUTE OF PHYSICS

ANNUAL REPORT

AT the annual general meeting of the Institute of Physics held on May 20, the following were elected to take office on October 1: *President*, Dr. F. C. Toy; *Vice-President*, Dr. E. T. Allibone; *Honorary Treasurer*, Mr. E. R. Davies; *Honorary Secretary*, Dr. B. P. Dudding; *New Ordinary Members of the Board*, Mr. J. H. Awbery and Mr. E. W. H. Selwyn. Dr. G. B. B. M. Sutherland has been appointed by the Faraday Society as its new representative on the Board.

The twenty-eighth annual report of the Board covering the work of 1947 was presented to the meeting. The report shows that the membership, now at about 3,250, continues to grow at the rate of a little more than ten per cent per annum. The Institute has seven branches, five in Britain and one each in Australia and India, and six subject groups, comprising electronics, industrial radiology, X-ray analysis, industrial spectroscopy, electron microscopy, and stress analysis. The last was formed in March 1947. All the branches and groups have each held several meetings during the year, and the report lists these in detail. In July, the Institute co-operated with the H. H. Wills Physical Laboratory of the University of Bristol in conducting a summer school, at which the attendance was 133, on "Cohesive Forces in Metals and the Mechanical Properties of Solids"; and, in September, with the Physical Society and in collaboration with the Institution of Electrical Engineers, it organised celebrations, including a special exhibition at the Science Museum, to mark the jubilee of the discovery of the electron.

The report shows that the Board has been active in matters concerning the education and training of physicists. The preparation of a report on developments in technological education has been undertaken (and has since been published); and to help in publicizing the newly established National Certificates in Applied Physics, the Institute has produced an illustrated booklet entitled "Experimental Science—A Career for the Practical Boy or Girl". The Australian branch, also, has in preparation a report on "Physics in Australia" and a booklet on "Physics as a Career". In addition to individual inquiries from members concerning professional matters, the Institute has, either through the Joint Council of Professional Scientists and other bodies on which the Institute is represented, or directly, dealt with difficulties in connexion with the re-organisation of the Scientific Civil Service, the collection of up-to-date data on salaries paid to physicists and on available scientific man-power.

In April 1946, the statement that "the Board was in full agreement with the views expressed by the President of the Royal Society regarding atomic energy and secrecy" was circulated to members of the Institute. The Board has since seen fit to amplify this statement, and has declared that it "strongly believes that atomic energy should only be used for peaceful and not warlike purposes". This, in its opinion, requires international agreement, and thus political action, which the Board feels is a matter best left to individual men of science. The Board agrees to promote the free exchange of scientific information between scientific workers of all countries; but it also realizes that it has been the practice for some to accept a measure of secrecy as a condition of their employment or service. In this connexion the Board is prepared to give advice to individual members.

The report mentions that during the year a scheme was discussed with the Physical Society for the establishment of an applied physics journal. It was decided, however, that it was not practicable, at present, to launch such a journal, and an alternative suggestion of the Council of the Physical Society that the Institute's publication, the *Journal of Scientific Instruments,* should be enlarged and a special section, of about forty per cent of its space, be devoted to 'non-instrument' articles, was adopted. Since January 1948 the *Journal* has appeared in this modified form under the new title of *Journal of Scientific Instruments and of Physics in Industry.* A second edition of the "Handbook of Industrial Radiology" was called for during the year, and among the new publications the Institute has in hand are a book of "Laboratory and Workshop Notes" selected from the Institute's *Journal,* and, in book form, the papers read at the 1946 Manchester Conference on the measurement of stress and strain.

Repairs and improvements to the Institute's House at 47 Belgrave Square, London, are proceeding steadily but very slowly, the report states, but already considerable benefit has been derived from the increased accommodation and facilities, which include a members' reading room, and a lecture room with a capacity of a hundred. It is anticipated that the essential work will be completed within two years.

COUNCIL FOR THE PRESERVATION OF RURAL ENGLAND

An indication of the nation's indebtedness to the Council for the Preservation of Rural England may be obtained from a perusal of the Society's annual report for 1947–48, obtainable from 4 Hobart Place, London, S.W.1. Foremost among the issues with which it has had to deal has been the vast problem of the post-war use of land for training the armed forces. The Council has been charged by the Ministry of Town and Country Planning with the duty of presenting evidence in writing, and if necessary verbally, on amenity and scientific grounds, in all cases where it is considered desirable that such evidence should be presented. On his afforestation policy the Minister of Agriculture has been advised on landscape planting and types of trees, while the Council's officers have also played their part in causing the cost-limit for the building of new houses to be raised in order that local stone might be used for facing in those districts where stone-built houses are traditional.

In conjunction with the Caravan Club and the Town and Country Planning Association, the Council for the Preservation of Rural England has set up regional sub-committees to eliminate (in the words of the Scott Report on Land Utilization in Rural Areas) "the nameless messes, the assemblage of caravans and converted buses and encampments which have littered and spoilt many a once charming stretch of coastline, lakeside and riverside, and a hundred other attractive scenes".

The submission of the Scott Committee that the introduction of carefully regulated suitable industries into the countryside would be beneficial has been endorsed by the Council and particular cases have been investigated, while the Council has also advised the Minister of Town and Country Planning on the location and design of wireless installations for the police and the B.B.C. Representations to the Postmaster General on the colour of telephone call boxes has enabled substantial agreement to be reached for those districts where objection is raised to the standard red of the 'Jubilee Kiosk'.

Opencast coal working has caused the Council much concern, and clear recommendations have been made to the Minister of Fuel on methods of regaining soil fertility and the restoration of land drainage after settlement as well as the general amenities. The reports of the Committee on National Parks were warmly supported by the Council; but dissatisfaction was registered with the Government's tardiness in implementing the main recommendations.

Other subjects dealt with by the Council during a year of considerable activity were the control of outdoor advertisements, the distribution and design of electricity installations, the siting and landscape treatment of road works and the preservation of buildings of historic and architectural interest.

CROPS OF THE CARIBBEAN

The Governments of the United States and the United Kingdom (1942), and later of France and the Netherlands (1945), united to establish a Caribbean Commission to encourage and strengthen social and economic co-operation between their various possessions and bases in the area known geographically and politically as the Caribbean. In order to survey needs, to determine what research has been done, to facilitate research on a co-operative basis, and to arrange for the prompt dissemination of the results of research, the Caribbean Research Council was set up in 1943. One of its research committees, dealing with agriculture, nutrition, fisheries and forestry, has instituted a series of crop inquiries in all territories, and the results of two such investigations have recently been published (Crop Inquiry Series No. 4, "Root Crops and Legumes", 1947, and No. 5, "Vegetables". Caribbean Commission, 1736 Vermont Ave., N.W. Washington, D.C., or Kent House, Port of Spain, Trinidad, B.W.I. 0.50 dollar per copy).

Agriculture in the Caribbean has traditionally emphasized production for export, on the theory that it is more advantageous to produce locally a high-priced crop (sugar) and buy low-priced foods in the world market. This has resulted in neglect of home-produced foodstuffs, and as the conclusions are similar for both publications under review, it is convenient to treat them together. Production of root crops, legumes and vegetables is unorganised, being mainly in the hands of peasants who cultivate small kitchen gardens about one-eighth of an acre in extent, as an adjunct to small-scale agriculture. Seed is generally imported, and is often of low viability owing to lack of cool storage. Pests and diseases are common, and there are only limited facilities for preservation of the produce. Yields are low; but it would appear that very considerable expansion of vegetable production is possible without disturbing the acreage devoted to sugar, which is the main crop. Two encouraging trends are a pre-war export of vegetables on a small scale from some of the territories, and some attempt at co-operative harvesting and marketing.

Details of all aspects of vegetable culture in each territory are set forth in the bulletins, which have been edited by Dr. H. W. Marston, with assistance (for Bulletin No. 5) from Dr. Gustave Burmeister, both of the United States Department of Agriculture.

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Monday, July 19—Friday, July 23

Congress of Universities of the Commonwealth (in the Examination Schools, High Street, Oxford).

Tuesday, July 20

At 10 a.m.—Discussion: "Relations of the State and the Universities".

Wednesday, July 21

At 10 a.m.—Discussion: "Inter-University Relations".

Thursday, July 22

At 10 a.m.—Discussion: "A critical review, from the points of view of an historian, a philosopher and a sociologist, of the structural and moral changes produced in modern society by scientific and technological advance".

Friday, July 23

At 10 a.m.—Discussions: "General Plans for Colonial Higher Education" and "The Extension of the University Secondment Scheme".

Institution of Civil Engineers (at Great George Street, London, S.W.1).—Conference on "Civil Engineering Problems in the Colonies".

Wednesday, July 21

British Standards Institution (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 3 p.m.—Annual General Meeting.

Thursday, July 22—Friday, July 30

Commonwealth Institute of Entomology (in the Large Chemical Lecture Theatre, Chemistry Department, Royal College of Science, Imperial Institute Road, London, S.W.7).—Fifth Commonwealth Entomological Conference.

Friday, July 23

At 10.30 a.m. and 2.30 p.m.—Discussions on Insecticides.*

Monday, July 26

At 2.30 p.m.—Discussions: "Biological Control" and "Estimation of Insect Populations in the Field".*

Tuesday, July 27

At 10.30 a.m.—Discussions: "Recent Developments in the Control of Stored Products Insects" and "Tsetse Research and Control".*

At 2.30 p.m.—Discussion: "The Need for Plant Quarantine on a Continental Basis, with Special Reference to Africa".*

Thursday, July 29

At 2.30 p.m.—Discussion: "Locusts and Grasshoppers".*

Friday, July 23—Saturday, July 24

Biochemical Society (in the Biochemistry Department, The University, Glasgow, W.2), at 11.15 a.m.—Scientific Papers.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant Keeper to be responsible for the Zoological Collections in the Manchester Museum—The Registrar, The University, Manchester 13 (July 24).

Experimental Officers at the Microbiological Research Department, Ministry of Supply, Porton, Wilts, for work in connexion with a pilot plant producing antibiotics—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2198 (July 24).

Lecturer (Grade II) in the Department of Physics—The Registrar, The University, Liverpool (July 24).

Senior Assistant Engineer and a General Assistant Engineer for Power Engineering Section, and a General Assistant Engineer for Light-current Engineering Section, in the Authority's Laboratory at Leatherhead—The Director of Establishments, British Electricity Authority, British Electricity House, Great Portland Street, London, W.1 (July 26).

Assistant Lecturer in Chemistry—The Registrar, The University, Reading (July 30).

Glass Delegacy Research Fellowship in the Department of Glass Technology—The Registrar, The University, Sheffield 10 (July 31).

Lecturer in Pharmacology—The Secretary, Welsh National School of Medicine, 10 The Parade, Cardiff (July 31).

Officer-in-Charge of Soil Microbiology Section, an Officer-in-Charge of Soil Ecology Section, and an Officer-in-Charge of Biological Assay Section, for the Soil Biotics Division, an Organic Chemist for Soil Chemistry Division and Soil Physicists (2) for Soil Physics Division, in the Soil Bureau of the Department of Scientific and Industrial Research, Wellington—Office of the High Commissioner for New Zealand, 415 Strand, London, W.C.2 (July 31).

Physicists (2) for Radio Section, a Senior Physicist (Officer-in-Charge) for Radar Section, a Senior Physicist or Engineer (Officer-in-Charge) for Electronics and Acoustics Laboratory, and Physicists (3) for the General Physics Laboratory, at the Department of Scientific and Industrial Research, New Zealand—Office of the High Commissioner for New Zealand, 415 Strand, London, W.C.2 (July 31).

Senior Lecturer in Plant Biochemistry at the University of Melbourne—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (July 31).

Lecturer in Mathematics (Pure Mathematics)—The Principal, Royal Holloway College, Englefield Green, Surrey (July 31).

Deputy Chief Scientific Officer in the Directorate of Engine Research and Development, Ministry of Supply, London—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2191 (August 5).

Histologist (Senior Research Officer or Research Officer) for the Division of Food Preservation and Transport of the Council for Scientific and Industrial Research, Brisbane—The Chief Scientific Liaison Officer, Australian Scientific Research Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 1772 (August 7).

Research Officer for the Division of Industrial Chemistry of the Council for Scientific and Industrial Research, Melbourne—The Chief Scientific Liaison Officer, Australian Scientific Research Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 1538 (August 7).

Senior Principal Scientific Officer in the Infestation Control Division of the Ministry of Agriculture and Fisheries—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2193 (August 9).

Director for the Central Glass and Ceramic Research Institute, Calcutta—The Secretary, Council of Scientific and Industrial Research, 'P' Block, Raisina Road, New Delhi, India (August 10).

Temporary Senior Lectureship in Mathematics at Auckland University College, Auckland, New Zealand—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (August 15).

Physicists or Engineers for Metrology and Acoustics Laboratories in the National Research Laboratories, Ottawa—The Scientific Liaison Officer, Canada House, Trafalgar Square, London, S.W.1 (August 16).

Professorship of Economic and Mining Geology at the University of Adelaide—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (August 31).

Entomologist for the Research Division of the Department of Agriculture and Forests, Sudan—Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, marking envelope 'Entomologist, Agriculture'.

Government Chemist in the Medical Department of the Gold Coast—The Director of Recruitment, Colonial Office, 15 Victoria Street, London, S.W.1.

Lecturer in Civil Engineering, a Lecturer in Mechanical Engineering, and a Lecturer in Mathematics—The Clerk to the Governing Body, Battersea Polytechnic, London, S.W.11.

Lecturer in Veterinary Science, a Lecturer in Genetics, a Lecturer in Horticulture, a Lecturer in Statistics and Experimental Method, a Lecturer in Poultry Husbandry and a Lecturer in Entomology, for the Canterbury Agricultural College, Lincoln, New Zealand—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1.

Readership in Biochemistry tenable at the Royal Cancer Hospital—The Academic Registrar, University of London, Senate House, London, W.C.1.

Research Worker in Chemotherapy and Tropical Medicine at the National Institute for Medical Research, London, N.W.3—The Secretary, Medical Research Council, 38 Old Queen Street, London, S.W.1.

Senior Scientific Officer to take charge of Biology and Chemistry Section (G.224/48A), a Senior Scientific Officer to take charge of Physics and Electronics Section (A.185/48A), a Scientific Officer for investigation of deterioration of materials and equipment exposed under tropical conditions (F.429/48A), a Senior Experimental Officer to lead a team working on Electronics (A.186/48A), and Experimental Officers and Assistant Experimental Officers for work in Chemistry (F.430/48A), Biology (G.225/48A), Physics and Electronics (A.187/48A), General Engineering (C.415/48A), for Ministry of Supply Tropical Testing Establishment, Port Harcourt, Nigeria—Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting relevant reference number.

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EXAMINATIONS AND SELECTION BOARDS

THE remarks which Sir Percival Waterfield, the First Commissioner of the Civil Service, made at Oxford in March regarding the low standard in personality and intelligence shown by applicants for entry into the Civil Service have aroused a considerable discussion and formed the subject of a debate on the Civil Service initiated by Viscount Mersey in the House of Lords on May 26. Sir Percival's statement that, of three thousand graduates interviewed, 40 per cent of those who wanted to go into the administrative service and 50 per cent of applicants for the foreign service scored marks for personality and intelligence which represented complete failure, is one of which industry and the universities as well as the Civil Service are bound to take careful note. His further statement that about five per cent of applicants for the administrative service and eight per cent for the foreign service were below even the lowest category may well be discounted, as was suggested in the debate, by war-time conditions and the absence of the screening which was practised by the universities with candidates for the written examinations; but the feature that, among those who failed, 60 per cent had university or college scholarships and 20 per cent were those who had State scholarships, should cause at least as much disquiet to the educationist and industrialist as to the Civil Service Commissioners.

The three fundamental questions which arise here were well indicated by Viscount Mersey in opening the debate: the training or education which the candidates have received; the tests or examinations to be applied to them when they desire to enter the Civil Service; and the qualities which are judged necessary for the Civil Service. This part of Lord Mersey's speech suggests that he was aware of the discussion on selection for management at the British Association meeting in Dundee last year. Neither he nor any other participant in the House of Lords debate, however, recognized that in selecting men for the Civil Service, or for any other walk in life, the chief requirement is, as Mr. A. Rodger pointed out at Dundee, a reasonably clear notion of what we are trying to assess. The first question to be answered is: "What are we looking for in our candidates?" Unless we can give a reasonably clear answer to that question, neither the written examination nor the selection board is likely to give us the men or women we require.

It might well be argued, therefore, that some of the criticisms of the selection—and rejection—of candidates for the Civil Service are due to the simple fact that, with the growth of the Civil Service and the increasing range and complexity of its duties, we have become less sure of the qualities we desire in our Civil servants, and less able to formulate precisely the relative weight we attach to initiative, integrity and other aspects of personal character for which no method of assessment yet exists, if, indeed, it could be found. We cannot expect to devise the appropriate methods of selecting and testing candidates while we are uncertain in our own minds about the precise requirements those methods are to meet. Even if that uncertainty and indecision were removed, we have still a long time to wait before we can be satisfied of the validity of the new methods, as was, indeed, repeatedly asserted in the debate by the strongest supporters of the new tests.

There are, in fact, sound reasons why we should not discard the intellectual tests, however imperfectly such written examinations may disclose the boldness, quickness, clarity and candour which, with self-discipline, marked the habit of Greek thought in its greatest days, as Prof. F. A. Adcock noted in his presidential address to the Classical Association earlier this year. Indeed, Lord Lindsay very pertinently remarked that people who showed themselves capable of passing searching written examinations with distinction could not be altogether devoid of ability. He himself thought that while the interview by the Civil Service Selection Board was much better in many ways than the half-hour interview, the right course was to restore the solid evidence of achievement in the written examination and supplement the examination with the interview.

Whatever the ultimate decision, it seems clear that, as Lord Moran suggested, we are only at the very beginning of a method of assessing accurately the suitability of men and women for the Civil Service or for any other sphere. The task should be approached in humility, and it is of the first importance that we should arrange for the records of candidates to be followed up to see whether they meet the criteria of success for the various branches of the Civil Service. These criteria are not really known with any certainty; but the time and expense of validation should not be allowed to constitute obstacles in a matter of such general importance.

Lord Simon of Wythenshawe as well as Lord Piercy were confident that the new methods had proved their worth by helping the Final Selection Board to make fewer mistakes and a better selection. Nevertheless, we are only at the beginning, and it may be possible to devise an entirely fresh system. Lord Elton, for example, in urging once more that since character as well as intelligence is indispensable to all high achievement, character as well as intelligence should be the concern of the scholarship examination, directed attention to the Rhodes Scholarship system, which for forty years has been trying to do exactly what the Civil Service Selection Board is now attempting by the new methods. Lord Elton believes that the traditional tests were over-narrow in that they confined themselves to selecting persons likely to absorb readily and reproduce lucidly the ideas of other people. He emphasized that the Rhodes selection committees have been able to rely greatly on the school and academic record of the applicant, and that on none of these sixty or seventy selection committees was there a psychologist.

Lord Pakenham, who concluded the debate for the Government, had little difficulty in showing that Lord Elton had gone too far in implying that the Civil Service Selection Board should likewise dispense with the services of the psychologist. He indicated that particular importance is attached to studying the previous records of the candidates, and he promised that some sort of White Paper on the subject would be prepared. His speech itself gave an admirable account of the working of the methods at present used; and he submitted that the Government is taking the wisest course in trying out both systems and seeking to judge which system appears to select Civil servants who will maintain and enhance the great traditions of the public service of Great Britain.

Lord Pakenham's speech dealt mainly with this question of selection boards; but he made several specific statements of considerable interest. First, he said that the Departments of State were emphatic that they were getting very good material; but that the standard for the Home Service, and to a lesser extent for the Foreign Service, appeared to have been pitched too high. Accordingly, in the Home Service it had been decided to lower the pass mark slightly. The Foreign Service authorities, who had decided to rely on the selection board method for their recruits during the next few years, had not yet decided how to fill their much smaller gap. Lord Pakenham agreed with Lord Lindsay that in the post-war period many people had entered for the examination who would not have entered before the War; but he also said that a later and larger sample of candidates than that cited by Sir Percival Waterfield gave figures of 26·6 per cent and 30·7 per cent, respectively, of candidates for the Home and Foreign Services who passed the original qualifying test but who were finally graded as out of the running.

Nevertheless, although this is a slightly more encouraging picture than that given by Sir Percival Waterfield, the Government is proposing to review the national State scholarship system, and the Minister of Education has appointed a 'working party' to consider, in consultation with local education authorities and others, the various problems concerned with university awards. It is to be hoped that the 'working party' will grapple with the question of character which Lord Lindsay emphasized in this connexion, for it grows more important as the proportion increases of candidates coming from schools where there are fewer opportunities for the training of character than in the public schools, where it is traditional. Something must be done, as Lord Lindsay suggested, to secure that the State scholarships do not go to those who take no part in the ordinary activities of the school. Nor is the problem solely one for tackling at the secondary school level; Mr. J. W. C. Adams, warden of Crewe Hall, Sheffield, points out in the *Universities Quarterly* of May, that many of the universities could do more to encourage participation in the corporate life of the university, both by making halls of residence a more prominent feature of the civic universities and in other ways.

The debate in the House of Lords accordingly confirmed the value of the experiments in selection now proceeding; but it also underlined their experimental character and emphasized that the experiments must be so conducted as to permit judgment after a year or two of their reliability. Equally, it vindicated the very high standard of the university man at the present day: there was no evidence that the universities are selecting the wrong people or training them wrongly, and the whole trend of the debate was against premature or excessive specialization, in science, the arts or any other field. Lord Cherwell in particular commended Sir Percival Waterfield's suggestion that no arts student should be without some knowledge of science, and no science student without some knowledge of the humane studies.

The increasing demands of the Civil Service on the trained man-power and woman-power of Britain raise the same problems of education and training. Just as the validity of the selection board's methods for the Civil Service is a matter of deep concern to industry, so the educational quality and attainments of the graduates from which both industry and the Civil Service are recruiting men and women are of much concern to them both. Nor indeed could the universities themselves be indifferent to the views of either industry or the State service in this matter, or attempt any considerable changes without having regard to both points of view.

The situation is already serious. It is clearly undesirable that an excessive proportion of the outstanding ability to be found each year among those leaving the universities of Britain should be drawn into any one section of life. It has already been suggested that the Civil Service is obtaining more than its fair share of the first-rate ability at present available. The nation is best served by a reasonable distribution over all those spheres of life which call for such gifts. Statements by Sir Lawrence Bragg and others have indicated some reluctance on the part of the ablest science students to enter industry. If such a tendency became too marked, the effect on industry would be serious. It would be equally unfortunate if industry itself attracted too large a proportion of our most gifted investigators and left the universities depleted in this respect.

Before the schemes of university expansion proceed too far, we should therefore reconsider the whole question of the aims and content of university education. Something more should be done along the lines that Dr. Percy Dunsheath attempts in his recent book "The Graduate in Industry"*. The graduate needs to be informed about the openings that exist in industry and the real conditions of work which obtain there; equally the industrialist does not always appreciate the contribution which the trained mind, when matured by experience, can make to industrial efficiency. Dr. Dunsheath has indicated many ways in which the university appointments boards could make invaluable contributions to the more effective use of trained man-power. From them, too, may well be expected some of the quantitative data by which we should revise our estimates for the rate and direction of university expansion, particularly if, as seems likely, difficulties arise in meeting the requirements for graduates in applied science suggested in the recommendations of the Barlow Committee on scientific man-power in 1946. Beyond this there is a wide field for research into the demands which various occupations make upon, and the scope they afford to, the various attributes of human personality.

The House of Lords debate is to be welcomed for putting the whole problem in its true perspective. It is not simply a question of the methods by which industry and the State can best select their recruits. Nor is it solely a question of the conditions which will enable the universities, industry and the State to attract to their service a fitting proportion of the ablest minds available from those graduating each year, or even of the way in which those men and women are to be trained and nurtured before they enter the universities, during their residence there, and in their subsequent careers. What stands out above all is that an unparalleled opportunity for experiment is in front of us, of which selection methods are only one facet. The problem of the development and wise use of the trained man-power and woman-power of Britain calls for the closest co-operation between industry, the State and the universities, as well as those institutions like the British Institute of Management and the National Staff Administrative College which are seeking to explore new methods and raise the whole standard of administration. Further, it should be remembered that, both in industry and in the Civil Service, the wise and full use of our ability involves increasing attention to its use and training after recruitment, so as to ensure that the keenness of young and able minds selected with so much care is not blunted by failure to use their talents to advantage, and in ways that afford satisfaction to their ideals as well as to their intellect and personality.

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* The Graduate in Industry. By Dr. Percy Dunsheath. Pp. x+276. (London: Hutchinson's Scientific and Technical Publications, n.d.) 10s. 6d. net.

WHAT IS PHYSICAL CHEMISTRY?

(1) Rational Approach to Chemical Principles

By Dr. John A. Cranston. Pp. xii+211. (London, Glasgow and Bombay: Blackie and Son, Ltd., 1947.) 8*s*. 6*d*. net.

(2) The Elements of Physical Chemistry

By Prof. Samuel Glasstone. Third printing. Pp. vii+695. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1947.) 25*s*. net.

(3) Physical Chemistry

By A. J. Mee. Third edition. Pp. xix+782. (London: William Heinemann, Ltd., 1947.) 20*s*.

(4) Physical Chemistry

By Dr. E. D. Eastman and Prof. G. K. Rollefson. (International Chemical Series.) Pp. viii+504. (New York and London: McGraw-Hill Book Co., Inc., 1947.) 22*s*. 6*d*.

PHYSICAL chemistry emerged as a separate subject at a time when physics and chemistry were separated by a fairly wide *terra incognita*, and the application of physical and mathematical methods to chemical reactions and equilibria offered an attractive field which was catered for by neither of the parent sciences. It soon developed a homogeneous subject-matter of its own, which has remained the backbone of physical chemistry courses ever since. It is natural that most of the new methods and fundamental conceptions of the behaviour of matter, which have contributed to the fuller understanding of chemical reactions and modes of combination, should have come from the experimental and mathematical branches of physics, and the role of the physical chemist has been to ensure the immediate and effective application of these methods and conceptions to chemical studies.

Now that the frontier between physics and chemistry has disappeared, the task of the physical chemist is by no means so clear. On one hand, the mathematical description of chemical combination has become a highly specialized branch of higher mathematics; on the other, the physicists have provided an armoury of weapons, such as X-rays, spectroscopes, mass spectrographs, electron microscopes, isotope techniques, etc., which are so demanding that their users tend to remain experts in their particular fields. In these circumstances, what should be taught to students as physical chemistry? Should it be those parts of physics which are most useful to the chemists? Or should it be the borderline region which concerns itself with the nature of chemical combination and the mechanism of chemical reaction—perhaps leaving the more mathematical aspects to the chemical physicist?

Faced with this vast and confusing extension, it is not surprising that teachers of physical chemistry have been much concerned with what to put into their courses and what they can safely leave out. That the times seem to many teachers to call for a re-orientation of physico-chemical studies is shown by the large number of recent text-books in which new interpretations have been offered of the subject.

The four books under review all reflect this tendency. Dr. Cranston's little book offers a new approach to physical chemistry in the school. He states his objective as follows: "It appears to the author that no more promising step . . . could be taken than ruthlessly cutting out the historical approach to the subject. The study then becomes a rational one. The physicist's atom is taken as the starting point and a reasonably detailed picture of its structure is drawn. The fundamental laws of chemistry . . . then tumble out of the picture in a perfectly rational way." The reviewer thinks that Dr. Cranston has justified his claim except in one respect. The introduction of the atom first has led him to describe the quantum numbers of the atoms in the periodic scheme on p. 21, while it is not until p. 80 that we are introduced to the conservation of energy or even the units of energy. Surely it is asking a little too much of the intuition of even "the average school boy, who, in an age of wireless, is already familiar with many aspects of electricity", to expect him to make any sense of the distinction between magnetic and spin quantum numbers, at the very beginning of his studies. A very simple picture of the atom would be adequate for everything which follows.

How to deal with atomic structure, in fact, presents a difficulty to all these authors. It obviously comes within the category of "those parts of physics which are most useful to the chemist", forming, as it does, the whole basis of his conception of matter; but it does not fit in very well with the more usual curriculum of physical chemistry which follows. Both Glasstone and Mee tackle this question at or near the beginning, but Eastman and Rollefson, for some reason, interpolate it between the liquid state and solutions. The reviewer would suggest leaving it out of text-books of physical chemistry entirely, and letting it be studied, empirically treated as it is, under *inorganic* chemistry. Those students who want to delve deeper should be encouraged to get help and inspiration from their physics departments.

Prof. Glasstone's book, a new addition to his series of text-books, is in a style familiar to his many readers, and provides, at a more elementary level than his "Text-book of Physical Chemistry", a clear and straightforward account of the subject. Its references for further reading are entirely to articles in the *Journal of Chemical Education*—a fact which makes it less suitable as a text in Great Britain than across the Atlantic. A further feature is the large number of revision questions, which enable the student to test his knowledge and perhaps anticipate his examiner's choice.

Mr. A. J. Mee's is a new edition of a well-known book, which will require no recommendation to users of the previous editions. The text of Profs. E. D. Eastman and G. K. Rollefson is perhaps the most comprehensive of the four books under review, as may be judged from such entries as the radial distribution of atoms in silica glass, infra-red frequencies of chemical bonds, and tracer studies with radioactive atoms. Readers can decide for themselves whether the book covers adequately the seven objectives of physical chemistry which are listed in the first chapter. Space does not permit quoting these in full, but how widely the authors interpret the subject can be judged from their seventh objective: to describe, interpret or predict . . . "the molecular, atomic and subatomic structure of the constituent particles"!

The last three books might well have given more space to the rapidly expanding applications of physical chemistry in the biological field. Out of about 700 pages, Glasstone devotes 24 to the colloidal state and Mee about 29, while Eastman and Rollefson do not mention it (they have a brief chapter on surface phenomena). This is inadequate at a time when chemistry is becoming increasingly concerned with larger molecules, both of living and of non-living origin.

The most striking feature of these and of other recent text-books of physical chemistry is the fact that they adhere so closely to the traditional curriculum. Writers of introductory texts are naturally concerned mainly with the past, and are wise not to concentrate too much on ephemeral 'recent advances'. Perhaps it is asking too much to expect them to distinguish the trend of the present day and so anticipate the future needs of the present generation of students.

J. A. V. Butler

APPLIED ELECTRONICS

Electronic Circuits and Tubes

By the Electronics Training Staff of the Cruft Laboratory, Harvard University. Pp. xxiv + 948. (New York and London: McGraw-Hill Book Co., Inc., 1947.) 45s.

THIS book sets down, in nearly 1,000 pages, the greater part of the war-time course given to U.S. officers at the Cruft Laboratory, Harvard University. The range of material included is necessarily very great and, as Prof. Chaffee has frankly stated in his foreword, ". . . the scope and the method of presentation of the material in this volume are not on a graduate level. . . ." Indeed, this could not possibly be so in a single volume which includes: A.C. vector theory; bridge and other measurements; transient analysis; network theory; wave-filters; thermionic emission; electron dynamics; transmitter and receiver circuits; gas-discharge tubes; modulation theory; timing, rectification and control circuits. The treatment is essentially technological and, in many places, merely descriptive.

The recent flood of books on the more technological aspects of electrical communications makes one search any new publication for positive contributions to the art; in this respect, this book is saved by certain novel treatments. In particular, attention may be directed to the use of surface models in connexion with coupled circuits, and to the simple approach to the problem of transients and signal distortion.

Against these favourable points must be weighed the very condensed and sketchy treatment of certain topics. Thus, magnetrons are dealt with in one page, while klystron and other micro-wave tubes are omitted (in spite of the title). Transmission line theory has been included in a companion volume dealing also with wave-guides and antennæ, and this has necessitated treating wave-filters from the beginning as finite structures, which, though the more practical condition, results in an unwieldy presentation likely to be confusing to the beginner.

To two appendixes are relegated the elements of the relevant mathematics, electricity and magnetism: Appendix (*a*) opens with the definition of powers of a number and meaning of logarithms, and Appendix (*b*) with the inverse square law. If it be assumed that the reader needs to start at such elementary levels, it is unlikely that he will learn much from such intense cramming. It would have been preferable to have used this space for expanding the main text, giving references to good elementary text-books which might supply the foundations.

The urgency of the War required the rapid training of great numbers of people, with varying backgrounds, in the application of electronic techniques. But the value of such a course is doubtful now. Nevertheless, there must be many scientific people, possessing a suitable grounding in mathematics, electricity and magnetism, who may be interested in applying such techniques to their particular branch of science. For them, this volume may serve as a reference book and as a guide to the literature. There are a few, but select, references and a clear index; the diagrams are good, and the style is consistent in spite of the joint authorship.

E. C. CHERRY

METABOLISM OF DRUGS

Detoxication Mechanisms

The Metabolism of Drugs and Allied Organic Compounds. By Dr. R. Tecwyn Williams. Pp. viii + 288. (London: Chapman and Hall, Ltd., 1947.) 25*s*. net.

THIS is the first monograph to be published in English describing the chemical changes which drugs or other substances foreign to the body undergo when administered to animals. It is undoubtedly a useful compendium of the work which has been carried out in this field. Dr. R. T. Williams excuses his title on the grounds that the subject has been treated under such a heading in text-books of biochemistry. The title is, however, too narrow for the subject. Many of the reactions considered are certainly not detoxication processes. Thus the conversion of the azo dye prontosil into sulphanilamide appears to be an activation, and the metabolism of some substances such as picric acid and trinitrotoluene leads to more toxic products. The functions of the biochemical changes are unknown in most cases. "Detoxication Mechanisms" is rather a teleological expression, and the reviewer would like to suggest that another title or even the present sub-title be used for future editions. Even if it has become customary to use this term, there is no need to continue using a term which Dr. Williams admits if "Taken in its literal sense . . . becomes in many cases a misnomer".

The metabolic processes which are described include oxidation and reduction and synthetic reactions such as the formation of thiocyanate from cyanide of acetyl and methyl derivatives of amines, and conjugation with glucuronic acid, sulphate, glycine, acetyl cysteine, ornithine and glutamine. The changes are considered particularly in reference to different groups of compounds, according to whether they are aliphatic or aromatic and the nature of their substituent groups.

The changes which most normal body constituents undergo, such as phosphorylation or oxidation, are often the same in all species, from bacteria to the higher mammals. The changes undergone by drugs and purines, however, show remarkable differences. Thus phenylacetic acid is conjugated with glycine by most mammals but with glutamine by men and chimpanzees and with ornithine by fowls. Aromatic amines are acetylated by most animals and birds, but not by dogs. The metabolism of β-naphthylamine shows interesting differences. When given to dogs, in which species it induces cancer of the bladder, it is excreted as 1-hydroxy, 2-amino derivatives; but in rats, rabbits and monkeys, in which bladder cancer has never been induced with this compound, 6-hydroxy, 2-acetylamino-naphthalene is produced.

The biochemical changes which synthetic substances undergo in the body give an indication of capabilities which would otherwise pass unrecognized. Thus the acetylation of amines is most easily demonstrated with foreign substances such as the sulphonamides. The study of the metabolism of phenyl-substituted fatty acids gives indications of the metabolism of fatty acids in the body. In this case the phenyl group acts as a tracer. Dr. Williams considers that there is no satisfactory unitary theory for the processes considered. Substances foreign to the body are probably changed chemically because they resemble natural body constituents sufficiently closely for them to become substrates of existing enzymes. A fresh drug may stimulate the body to produce a fresh enzyme by adaptation, but in many cases animals metabolize foreign compounds as soon as they are administered.

Dr. Williams has produced a useful compendium of the facts of the subject which will be of value to many biologists with interests in pharmacology and chemotherapy. When more facts are known, it might be possible to generalize and introduce satisfactory hypotheses for the innumerable chemical processes which the animal body can carry out.

E. BOYLAND

Modern Rubber Chemistry

By Dr. Harry Barron. Second edition. Pp. viii + 502. (London: Hutchinson's Scientific and Technical Publications, 1947.) 36*s.* net.

The Water-Soluble Gums

By Dr. C. L. Mantell. Pp. v + 279. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1947.) 36*s.* net.

IN "Modern Rubber Chemistry" Dr. Barron covers an immense field, stretching his title to include such topics as fabric construction, mould design and physical testing. The author's intention of being understood will be largely achieved, but there are some repetitions and examples of careless writing. A more selective account of early work would permit a clearer treatment of the scientific principles underlying, for example, the structure of rubber and the theory of vulcanization. The work of Farmer and his co-workers on this latter topic is surprisingly omitted. The useful analogy of likening the process of polymerization to the joining of hands is weakened by an unnecessary reference to chain formation through secondary valencies. The work as a whole can, however, be recommended as a valuable text-book on the technology of rubber.

Accompanying an increased insight into the structure and properties of synthetic polymers, our knowledge of many naturally occurring substances has been greatly enriched in recent years; indeed, many significant advances in high polymer science have resulted from studies on cellulose and natural rubber. It is of interest to note that while Dr. Barron turns to current high polymer theory to clarify some of the obscurities of rubber behaviour, this approach is not evident in Dr. Mantell's work.

"The Water-Soluble Gums" is a comprehensive account of the sources, collection, manufacturing processes and applications of a class of substances obtained mainly from plants. Gums are here described loosely as hydrophilic colloids, and it seems possible that the scope of the subject might be better defined by the phrase "Water-Soluble High Polymers". This definition would necessarily include polyvinyl alcohol, which is rapidly assuming importance, particularly in the United States, as a 'synthetic gum'. In general, the treatment of the subject is somewhat uncritical, and recent work on chemical constitution is not adequately described.

Volumetric Analysis

By Prof. I. M. Kolthoff and V. A. Stenger. Second revised edition. Vol. 2: Titration Methods; Acid-Base, Precipitation, and Complex-Formation Reactions. Pp. xiii + 374. (New York and London: Interscience Publishers, Inc., 1947.) 36*s.*

THE issue of the second revised edition of this standard work on volumetric analysis will be welcomed by a wide circle of analytical chemists. The book under review, the second of a set of three volumes, confirms the favourable reception accorded to the first edition.

This volume is divided broadly into three parts: (*a*) apparatus and general principles describing equipment and technique needed to achieve the best results with volumetric methods; (*b*) acid-base reactions, which include standard titrations and reactions involving displacement, hydrolytic precipitation and complex formation; and (*c*) quantitative precipitation and complex formation reactions in which titrations with silver nitrate, potassium ferrocyanide and many other reagents are described.

Within the scope of this book, which does not include oxidation-reduction methods, the treatment is very comprehensive and contains a wealth of practical detail and shrewd comment. Many references and notes are included, but, as the authors point out, the lack of information during the war years has prevented a full description of work published outside the United States since 1940.

This book is recommended with confidence not only to analytical chemists but also to workers in other branches of chemistry.

Chemistry in the Service of Man

By Prof. Alexander Findlay. Seventh edition. Pp. xx + 390. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1947.) 12*s.* 6*d.* net.

THE appearance of a seventh edition of this widely read book is timely and welcome. It has long been recognized as a valuable general account of the way in which the science of chemistry helps to meet the needs of mankind. Advances, both scientific and technical, have been so rapid of late that it is essential for the subject to be reviewed at frequent intervals, all the more so because of the effect of war.

Prof. Findlay has carried out such a review admirably in this latest edition. He handles his vast theme with authority and skill. A wise selection of material has been made, and the subject-matter has been kept up to date without a loss in the general balance.

As in previous editions, sound scientific treatment is happily married with a most agreeable ease of style.

Honey and Your Health

A Nutrimental, Medicinal and Historical Commentary. By Dr. B. F. Beck and Dorée Smedley. Pp. 231 + 21 plates. (London: Museum Press, Ltd., 1947.) 12*s.* 6*d.* net.

THIS book is really a companion volume to the late Dr. Beck's earlier work "Bee Venom Therapy". Although it is difficult to accept some of the author's views with regard to the nutritional advantages of honey over other mixtures of sugars, it is almost impossible not to become infected by his enthusiasm, and to enjoy reading the folk-lore about honey which he has collected together from so many parts of the world. His history of the uses to which honey was put in bygone times makes fascinating reading and will, I feel sure, give pleasure to many people besides those who keep bees. Incidentally, this book contains some excellent recipes in which honey plays a major part.

COLIN G. BUTLER

Sociology of Religion

By Joachim Wach. (International Library of Sociology and Social Reconstruction.) Pp. xii + 429. (London: Kegan Paul and Co., Ltd., 1947.) 30*s.* net.

THE author summarizes and reviews the literature dealing with the forms, social expressions and general social relations of religion in all its various manifestations. It is a work of immense erudition. The index occupies 29 pages and the number of footnote references is (roughly estimated) 5,000. As a work of reference it is undoubtedly useful and well worth publishing. It is very doubtful, though, whether anyone will have a better understanding of religion after reading the book than he had before, or even a better understanding of sociology.

A. D. R.

THE INDIAN FOREST SERVICE

By PROF. E. P. STEBBING
University of Edinburgh

THE passing of the British forest officer from India, where a succession of young men possessing that British intuitive love of an open-air life, with a touch of the adventurous in it, has built up a magnificent forestry property for India, merits a record. It has been a work which has had a minimum of publicity, due perhaps to the failure of the forest officer (until comparatively recently) to write for the public.

The history and work of the British forest officer in the teak forests of Burma was reviewed in *Nature* of December 13, 1947 (**160**, 818). Earlier, in *Nature* of September 8, 1945 (**156**, 286), an article on "Post-War Forest Policy in India" was published. When the memorandum discussed in the latter article was written by the Inspector of Forests to the Government of India, the decision as to the future political division and status of the country had not been settled, and it was considered likely, in fact probable, that many British forest officers in the different provinces would continue to serve out their time under whatever Indian government or governments were set up. This, in the event, has not proved generally to be the case.

The history of the forests of India from the practical point of view commences with the introduction of British administration into the country after the defeat of the French; as distinct from the earlier days of the East India Company, which only maintained trading posts at Bombay, Madras and Bengal. It was after the defeat of Tippoo Sahib in 1799 at Seringapatan in the south that British administration spread throughout a large part of Madras, and was accelerated in portions of Bombay and lower Bengal. The administration extended almost in spite of ourselves, the forward progress being necessitated if the areas already under British rule were to be safeguarded; it was not premeditated.

The gradual extension of British rule soon began to have its effect on accessible forests. The partition of the provinces into divisions and districts necessitated the erection of headquarters buildings in each, the construction calling for large amounts of timber. The military authorities required timber for many purposes, while the Admiralty at home and the smaller dockyards around the coast of Britain and at Bombay were soon taking increasing amounts of teak timber from the forests in the south, Malabar, Travancore and southern parts of the Central Provinces and Hyderabad, etc. The population of India, now living under settled conditions, rapidly increased in numbers, and in their old-time demands on the forest for fuel, grazing and small timber. In the south, teak was the only timber in use. It was the difficulties in meeting the requirements of the Naval dockyard in Bombay that resulted in the appointment of Dr. Gibson as *ad interim* conservator of forests in Bombay in 1844, with an assistant conservator and small office establishment; these were the first appointments of the kind in India. Gibson was confirmed conservator of forests in 1847. In Madras it was not only the Government's and Army's annual teak supplies which were causing the gravest concern, but also the scarcity of firewood for Madras city and the hill station at Ootacamund which eventually led to the appointment of Dr. Cleghorn as conservator of forests in 1856. He was given three assistants. Shifting cultivation was rife in both presidencies when the British took them over. It was due to their efforts that this wasteful utilization and destruction of the forests had been, to a great extent, eliminated by Government order by 1860.

In the northern half of the country on the eastern section, sal (*Shorea robusta*) was the only timber in common use, and Government departments, in the absence of teak, would only take this type, while in the north, Punjab, etc., the chief timber in common use was the deodar (*Cedrus deodara*) brought down from the outer Himalaya. The partial disappearance of the accessible teak forests in Malabar, on the west coast of Madras, was the first intimation that forests were not inexhaustible, and from the middle thirties of last century, the recognition that some form of control would be necessary was gradually forced upon the Government of India, not only in connexion with the large annual Government requirements in the three timbers mentioned (the deodar after the capture of the Punjab in 1850), but also to safeguard the requirements of the population itself throughout much of the country.

Many attempted panaceas in short-term measures, to tide over sudden emergencies, were made before the position was faced squarely by the Secretary of State for India at home and the Governor General in India. The Indian Mutiny had come and gone, with, as a main first step, the commencement of the building of the Indian railways, for which large amounts of timber would be required, threatening, if left in the hands of timber contractors, to result in the extinction of large areas of timber forest. Correspondence between the Governor General and the Secretary of State, Sir Charles Wood, in 1862–63, resulted in the formation of the Indian Forest Service, and the appointment of Sir Dietrich Brandis as the first inspector general of forests. But it was one thing to create a forest service on paper and another to fill its ranks and to lay down the powers and duties of the new Service in connexion with the districts in which forests were situated, hithertofore entirely under the charge of the Civil district officer. From the first it was laid down that a conservator of forests should be appointed to each province (save where already in existence), his duties to be administrative and advisory to the lieutenant governor in charge of the province; and that the provinces should be divided up into a number of forest divisions, each under the executive control of an assistant conservator of forests. In the first instance, the new Service was filled by young men volunteering from the Army, the newly disbanded Indian Navy, and other sources. Many of those so appointed had some experience of the forests gained on private shooting expeditions. This served as a start; but Brandis soon realized that the fully trained forest officer would be required to introduce and maintain an effective organisation in the country. In the late sixties, with the consent of the Secretary of State for India, he commenced choosing yearly a few young men with sufficient acquaintance with scientific subjects—botany, zoology and so forth—who received their forestry training in France or Germany. In 1885 home training was started at the Royal Indian Engineering College, Coopers Hill, where it remained until 1905, after which probationers were trained at the University of Oxford, and eventually also at Cambridge and

Edinburgh. This training of British probationers for the Indian Forest Service persisted until about 1933; some Indian probationers were also trained in Britain, and eventually entered the Service up to 1939. Up to the outbreak of the First World War, the India Office advertised the number of probationers required annually, and the annual quota was selected before the specialized training commenced. It was this consistent policy, maintained throughout so long a period, that produced a fine body of men who have, through the years, built up and brought to its present position the magnificent forest estate in existence. For now it can be readily recognized that it was the action of the Secretary of State and the Governor General in the early sixties of last century which saved the forests of India from extinction in all accessible (to the timber market) regions, while the smaller areas in the vicinity of villages and small towns would quickly have disappeared.

Perhaps the four most important steps taken in the pre-Forest Service period were the formation of the very successful Nilumbur teak plantations, initiated by Conolly, Collector of Malabar in 1843; the public recognition by Cleghorn, a few years after his appointment as conservator, that sylviculture must be introduced into the management of the Indian forest; and the recognition of the damage done to the forests by the shifting cultivator, and the virtual suppression of the practice throughout the greater part of Madras and Bombay. Lastly, the growing realization and conviction of the Government of India between about 1840 and 1860 that the forests of India at the time accessible to exploitation of all types, including the provision of fuel and grazing required by the rapidly rising population, which was primarily agricultural, were not inexhaustible.

After its inauguration, the Indian Forest Service made considerable headway during its first decade. Apart from the constant support and driving force of successive Secretaries of State for India at home, there can be little doubt that the rapidity with which it got fairly settled in the saddle was due to the policy of railway construction adopted at the period. Buildings were required and wood fuel for the engines; also the sleepers for the tracks had at this time to come from the forests in the regions concerned, teak, sal and deodar. The unchecked exploitation of the forest by the timber merchant had been stopped. The brunt of the organisation for this enormous quantity of timber required fell on the young Department, and its energetic chief, Brandis. It is an Odyssey in itself, both the work and the names of the men mainly associated with it.

Some of the work during the first thirty years has already been dealt with in the article in *Nature* on "Post-War Forest Policy in India" referred to above. The main work of the Department, apart from exploitation and providing for the requirements of the people, lay in selecting and, after sanction, demarcating the forest reserves and protected forests in different parts of the country (including Burma), in laying down and cutting a network of fire traces for their protection, and in the division of the forest blocks by lines or rides into the unit of working and supervision termed the 'compartment'. This was a gigantic task which in the main was completed by the end of the century. To enable forest reservation to be legal, a special Indian Forest Act VII of 1865—amended by Act VII of 1878—was enacted. Separate Acts were passed for Madras, Bombay and Burma. The fire protection policy, the first attempted in a tropical country, was based on a first successful attempt to protect the Bori teak forests in the Central Provinces from fire during the hot weather season. At the period, fires ran unchecked across the countryside in India during the hot weather, and the consensus of opinion held that it would be impossible to protect the forests from their customary baptism of fire. Forest officers of those decades can tell of the hardships of fire-fighting during the hot weather months. But great results were achieved.

During the latter part of this period in the more advanced forests of the country it was possible to give up departmental exploitation and introduce the method of marking standing trees in the forest for sale, their felling and removal being undertaken by the purchaser, thus enabling the forest officer to turn to a study of the sylviculture of his forests, and other professional duties. It was in this way that a beginning in the preparation of working plans took place in India. From the appointment of Brandis in 1863 as inspector general of forests, to the end of the century, three men occupied the post, himself and two other Germans, W. Schlich, and B. Ribbentrop, who had been recruited as fully trained young German forest assistants, and sent out to India in January 1870. Schlich held the post only for a couple of years, 1883–85, when he accepted the appointment as professor of forestry at the newly organised forestry school at the Royal Indian Engineering College at Coopers Hill. Ribbentrop held the post with distinction up to 1900.

The next great departure, and one which on considering the history and order of the progress would have been misplaced had it occurred earlier, that is, before the reservation of the bulk of the forests contemplated had been achieved, was the formation of the Imperial Forest Research Institute by Lord Curzon in 1906. By now the officers in charge of the forest divisions throughout the country had much more time to give to purely forestry problems, and moreover, in the more advanced forestry areas they had the advantage of ranger executive officers who had been trained at the (N.C.O.) ranger's class at the Dehra Dun Ranger's College, instituted in 1885. Many of the divisional forest officers had problems which urgently needed study by the research officer. Sir Sainthill Eardley Wilmot was the inspector general of forests at the time, and to him and the Viceroy belongs the credit of taking a step which was to have widespread ramifications, although it is impossible to go into the matter in detail. When Curzon asked the Inspector General where he was going to get his research officers from he replied, to the Viceroy's expressed amazement, "from the Forest Department". The Agricultural Research Institute for India had been inaugurated a few years before, also under the ægis of Curzon; but its officers had all to be recruited from home. One outcome was the new research building, built at Dehra Dun and opened in 1912, which quickly made its value apparent during the First World War—so much so that at the close of that war a new building on a far larger scale, outside Dehra town itself, was projected and sanctioned by the Government of India at a cost of one million pounds. This has been functioning for many years, and once again, during the Second World War, was its value to India and the fighting forces fully shown. The introduction of research as a part of the work of the Forest Department necessitated some form of publications of the investigations achieved. These are now well known. During the previous century there were no official publications of the Department. *The Indian Forester*, a monthly magazine, started in 1885 and still issued, was a private departmental publication.

As research work progressed, it gradually became obvious that some decentralization would be necessary; for example, one or more provinces might have a major sylvicultural problem requiring study by the sylvicultural research officer. Even with the assistance provided at the Institute, it was not possible to answer all calls. The selection and appointment of local research officers in the provinces which required them was sanctioned, and thus came into being the local research, sylvicultural, forest entomologist, and utilization officers, and, as important as any, the provincial conservator of working plans. These officers kept in close touch with Dehra Dun.

Reference was made in the article in *Nature* on the teak forests of Burma to the great progress made in working the forests under carefully prepared working plans. In India, by the opening of the Second World War, a network of plans for the forest reserves was in force, and many of these had been revised more than once. Since their early and tentative introduction, great advances had been made in the scope and intensity of management of many of these plans. The one *sine qua non* of the working plan, if properly prepared, is that all over-felling is permanently checked. Briefly, only the annual yield, that is, the annual increment put on the trees, is cut. In the memorandum on "Post-War Policy in India, 1944", the Inspector General of Forests was able to write on the subject of excess war fellings in the Government reserve forests in India: "Little is required to restore the departure from normal, that is the excess War Fellings; a 40–50 per cent reduction in pre-War yields for a period of five to ten years, may in some cases be necessary. The true position can be determined by the revision of the Working Plans which must, therefore, be accelerated after the War." This is forestry management brought to a high standard of efficiency.

Lastly, since the financial aspect of this great undertaking by Government forms one of its aspects, the following figures speak for themselves:

Revenue in 1868–69 = Rs. 40,38,800 and Surplus Rs. 12,65,467.
Revenue in 1936–37 = Rs. 4,38,07,019 and Surplus Rs. 1,53,58,194.
(last year before separation of Burma)

In addition, forest produce to the value of Rs. 84,14,946 was given away free or at reduced rates during 1936–37.

This article has no concern with political questions. It is merely a parting—a farewell to the Indian Forest Service. But in the light of the long experience I have been fortunate to have had in following the progress of the management of the forests of India, and in the study I have been able to make of the history of those forests, it may not be out of place to put out a word of warning. In the case of forests in which the management has been brought along the road to efficiency in working, as understood by the forester using these words, there can be no standing still, no relaxation of supervision, either by the gazetted officer in charge or his chief ranger executive officer, and no delegation of important sylvicultural operations—the constant inspection, for example, of young crops of regeneration until they have passed out of the danger period, the marking of thinnings upon which the whole future of the timber crop depends, and so forth—and equally and all-important, no over-felling, even in an emergency, without a full recognition by the higher authority of its necessity. These are fundamentals. That they have not only been introduced but also maintained in the Government forest estate in India, the Second World War has effectually proved.

I would say this to India and Pakhistan. The British forest officer has built up not only a great legacy which he now makes over to the owner, but he has also brought it to a pitch not, I believe, existent in any comparable area of forest in the world. If it is a proud legacy to leave behind, it is an equally proud one to take over. In the hands of the India and Pakhistan forest officers, the world will watch with interest the further great progress to be achieved, a progress which will afford lessons in tropical forest management for both the executive forester and the research officer, wherever he may be working.

THE WORK OF THE NATIONAL PHYSICAL LABORATORY

THIS year, 'open days' at the National Physical Laboratory were held on June 21 and 22. On the first day representatives of industry, including many from organisations having no previous contact with the Laboratory, took this opportunity of seeing the large variety of research and investigational work that is undertaken. On June 22, the occasion of the annual inspection by the Laboratory's General Board, of which the president of the Royal Society is chairman, the visitors included members of the scientific staffs of universities and Government departments.

During the last twelve months the work of the Laboratory has been concentrated so far as possible on those short-term projects of the greatest immediate benefit to industry, although much has also been done during the year on the maintenance of the various national standards and on programmes of fundamental research. No outstanding new developments were on show, but the two hundred and seventy-two scientific exhibits well illustrated the work of the Laboratory's ten divisions, and mention will be made of a few of the more interesting items.

The aerodynamical work on the design of the proposed Severn Suspension Bridge, one of the most interesting exhibits in 1947, has now been transferred to an outstation where scale models are undergoing test in a large wind tunnel. The work of the Aerodynamics Division is largely concerned with problems of high-speed flight, and exhibits in the various tunnels demonstrated the work being done to improve flying performance by the use of specially designed low-drag wings and boundary-layer control by suction or blowing. Researches into problems of stability, control and flutter, increasingly important at high speeds of flight, are being carried on and a model 'xylonite' elastic wing, incorporating the major structural characteristics of a typical aeroplane wing, is used in the study of the twist of a wing caused by a change in distribution of the air loads and its effect on the response of the aeroplane to movement of the ailerons.

The Metrology Division has just completed for the first time since 1932 a comparison of the national copies of the Imperial Standard Yard and the International Metre with their respective principal copies.

Using specially devised equipment, a new high standard of precision has been attained. Interesting experiments carried out in the United States have established that when gold is irradiated with neutrons in an atomic pile, an isotope of mercury is produced which yields almost ideal monochromatic radiations when electrically excited. It will be possible in due course to propose replacement of the existing material standards of length by definitions in terms of the wave-length of this particular radiation.

Among the new machines made and designed by this Division was shown a floating-micrometer for measuring the diameter and rate of taper of tapered plug screw gauges.

An interesting new development in the Engineering Division is the setting up of a photo-elastic laboratory. The equipment on show included a photo-electric photometer for accurate measurements of the photo-elastic patterns. Work on heat transfer in pipes using mercury as the working fluid, started in 1938 but dropped during the war period, has recently been resumed, using an all-steel double-flow heat exchanger.

A strain-operated electronic trigger device designed in the Division was in operation on one of the special machines installed in the Lubrication Laboratory. This device will stop the machine should an increase in frictional force above a critical level indicate that seizure of the bearing under test is imminent. Small variations in strain of a weighbar are converted to voltage changes by an electrical resistance strain-gauge circuit, and when the strain exceeds a certain predetermined magnitude an electronic trigger is tripped which stops the machine before serious damage occurs. The principles underlying the operation of this device are thought to be applicable to a wide range of machines where the imminence of an unsafe condition may be accompanied by increase of linear strain in one element of the machine.

In the Physics Division the work of the radiology section on the protection of operatives against ionizing radiations and on the measurement of radio-activity is growing in importance with the increased availability of radioactive substances, and a comprehensive range of measuring and standardizing equipment was on show.

During the past year, further progress has been made with the extension of the section dealing with the fundamental work on acoustical standards of measurement. Among other developments which were on view was a room which has been provided for the standardization of microphones and other acoustical instruments. The walls of this room are lined with wedge-shaped absorbent constructions of the type now recognized to be exceptionally effective in suppressing reflected sound, thereby permitting field measurements of the highest accuracy.

A new quartz spectrograph has been installed in the Metallurgy Division, and together with a micro-photometer and a precision comparator forms the main equipment of the Spectroscopic Laboratory. One of the interesting activities of this Division is the preparation of new materials and the study of their properties, and attention is now being given to the preparation of the metals vanadium and titanium in a state of high purity. Little is known, so far, of their physical properties and metallurgical behaviour, and this investigation will yield useful fundamental data.

Another notable exhibit was a projection microscope adapted to phase-contrast illumination. In this form high parts of the structure under examination are revealed as bright areas; the low parts dark. Light reflected by the specimen is split into two parts, one being advanced in phase a quarter of a wave-length relative to the other by means of a 'phase-ring' in the objective lens. The two beams are re-combined and the interference between them produces the typical phase-contrast effect. The satisfactory working of the method calls for the replacement of the ordinary disk aperture by one of the ring type. The images are similar to those given by the electron microscope and so help towards appreciating the difference between electron microscope and normal optical microscope images. The phase-contrast microscope is capable of being sensitive to steps of surface-level of about 50 A.

The Electricity Division had on show equipment for extending the range of quartz-controlled oscillations to centimetric wave-lengths. A number of stages of frequency multiplication, mixing and amplification are used to obtain sources of oscillation of a power of about 3 watts having frequencies, controlled by the primary standard, of the following values: 33·6–36·8 Mc./s. in steps of 0·4 Mc./s., 67·2–73·6 Mc./s. in steps of 0·8 Mc./s. and 201·6–220·8 Mc./s. in steps of 2·4 Mc./s. By using these oscillations and their harmonics up to the order 36, controlled frequencies are obtained throughout the range 350–8,000 Mc./s. at intervals of 1 per cent. A variable frequency oscillator, monitored by the standard, enables values between the controlled frequencies to be obtained without appreciable loss in accuracy. Two further stages to be added will extend the range to 50,000 Mc./s.

The most obvious application of the equipment is the rapid and precise calibration of wavemeters, but the sources at their fundamental frequencies will also serve for the testing of cables and dielectrics. An application of more fundamental importance may be the study of the radio-frequency spectra of atoms and molecules. The spectra of a number of gases have been examined both in Great Britain and the United States during the last three years, and that of the ammonia molecule, for example, has lines in the neighbourhood of 23,000 Mc./s. the frequencies of which have been measured to a precision of 1 part in 10^6. Such lines can be used as standards of frequency, and the possibility of obtaining molecular standards of this kind is exciting considerable scientific interest.

In the High Voltage Laboratory, measurements of the time variation of the light from sparks are being made by means of a photo-multiplier, amplifier and cathode ray oscillograph. The immediate purpose is to provide a spark suitable for shadow photography in the Aerodynamics Division. The effects of electrode material and spark current are being studied and observations are being made on a gas discharge tube suitable for light pulses of 1 micro-second duration.

The Radio Division has developed a cathode ray direction finder for the location of thunderstorms at long ranges. The apparatus exhibited is similar to that used by the Meteorological Office and is of great value in problems such as the routing of aircraft over the Atlantic. A symmetrical arrangement of orthogonal loop aerials is connected to a twin-channel superheterodyne receiver which is tunable over the frequency range 10–30 kc./s., the normal operating frequency being 12·5 kc./s. At this frequency a minimum field-strength of 100 μV./m. (approximately) is required to give a full-scale trace on the cathode ray tube; but for normal operation on atmospherics in Britain, the balanced attenuators incorporated in the equipment are adjusted so that a full-scale trace is given by a field-strength of about 5 mV./m. Visual observation of the bearing on the cathode ray tube is generally employed, but the equipment can easily be adapted for photographic recording.

The Mathematics Division exhibited the comprehensive range of machinery that it has available for computational work; one room was devoted to an exposition of relaxation methods, which have a wider application than is generally supposed. The Division is also able to offer advice on the application of statistical methods to various research problems.

The work of the Ship Division continues to be directed mainly to satisfying the immediate requirements of the shipbuilding industry for the large volume of new construction both for British and foreign owners. Vibration of ships' hulls is a subject on which much full-scale research has been continued, especially on vessels with long superstructures such as passenger liners, and a vibrograph and accelerometer were shown, together with typical records taken at sea.

Research on the design of ships' propellers is carried on principally in the Lithgow water tunnel, which can be operated at reduced pressures to enable cavitation phenomena to be studied. The tunnel is also equipped with apparatus for the measurement of the thrust delivered by the propeller and the shaft horse-power absorbed.

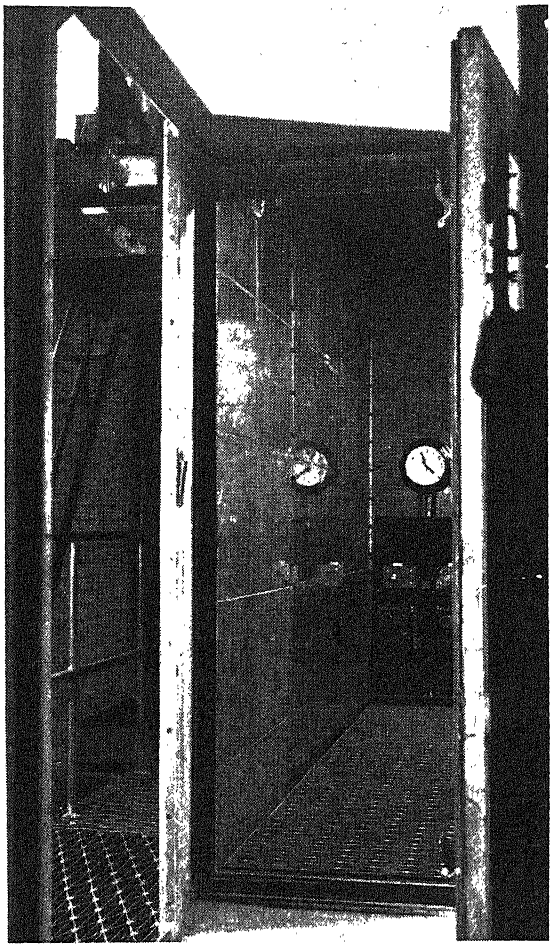
The Light Division displayed an interferometer capable of comparing the flatness of two surfaces up to 12 in. in diameter. The surfaces need not be in actual contact, although their separation should preferably be small. The observer is able to view, at normal incidence, the interference fringes formed between the surfaces, and means are also provided for recording the fringe system photographically. Examination of the record enables departures from flatness of the order of 0·01 microns to be measured.

Among the exhibits in the Photometry Section of this Division was apparatus for studying the spectral response curves of the various mechanisms in the human retina. The principle is to measure the smallest perceptible intensity of a monochromatic test stimulus applied at a particular point of the retina when the latter is brought into various states of adaptation by exposure to a coloured light-field, which may or may not be of the same wave-length as the test spot.

CALORIMETER BUILDING FOR DOMESTIC HEATING RESEARCH AT THE FUEL RESEARCH STATION, GREENWICH

By Dr. A. C. MONKHOUSE

CONSIDERABLE attention has been paid in recent years to the more efficient use of fuel for domestic purposes, and to the development of better appliances for space heating, cooking and water heating. The amount of coal used directly for domestic purposes is about one-quarter of the total coal consumption in Great Britain. If the indirect use as gas, coke and electricity be included, the amount is one-third, or about 60 million tons a year. Improvements in the domestic use of fuel are of vital importance, therefore, in the economic and social life of the community.



Entrance to one of the calorimeter rooms

The Fuel Research Station of the Department of Scientific and Industrial Research has in the post-war years, in conjunction with other Government departments, research associations and industry, devised and undertaken tests to determine the performance of the various types of domestic appliances, particularly those using solid fuels. These tests involve the measurement of fuel consumption, the amount of heat emitted as radiation and convection, the heat imparted to the water, the loss of potential and sensible heat in the products of combustion, and the quantity of smoke produced. Some measurements, such as those of convection, are with many appliances difficult to determine directly and are usually assessed by a difference figure in the heat balance. To obtain more accurate data of the distribution of heat from an appliance, a special laboratory building has recently been erected at the Fuel Research Station at Greenwich; it was opened for inspection by Sir Edward Appleton on June 30.

The building is a four-story structure occupying a ground area of about 3,000 sq. ft. On the first floor are four rooms or cabinets, 12 ft. square and 9 ft. high, each mounted centrally in a constant temperature chamber 20 ft. square and 26 ft. 6 in. high. In these rooms, which are, in effect, calorimeters, the appliances to be tested are installed. The rooms are made of ¼-in. plywood, birch or gaboon, covered on the inside and outside with copper sheets 2 ft. by 1 ft. 6 in. Plywood has been chosen because of its low heat capacity, consistent with suitable thermal conductivity and mechanical strength. Each copper sheet is electrically insulated from its neighbour. Differential thermocouples are embedded at the mid-points of the copper sheets directly opposite each other on the inside and outside of the plywood, so that the difference between the internal and external temperature of the walls can be recorded. By suitable wiring the temperature difference can be measured through any individual panel, or the average through a group of panels such as a complete wall, floor or ceiling, and the heat-flow calculated. In practice, the calorimeter rooms are calibrated by a series of measurements when known amounts of heat are supplied from an electric heater operated at constant voltage.

An appliance to be investigated is mounted on a grating floor in the room, and the flue outlet connected through an opening in the ceiling to the chimney. The rooms are designed to be air-tight ; but the pressures inside and outside are automatically balanced by control of the flow of the inlet air, so that risk of leakage is reduced to a minimum. Air enters the room by a duct and its flow is measured by an orifice plate and is automatically recorded. The arrangement is novel as the appliance can be operated under natural draught conditions, while by use of the balanced pressure system the air flow can be accurately recorded. In addition, an auxiliary fan with a flow meter is mounted above the cabinet and can be used to extract ventilating air if required. The temperatures of the air entering and the products of combustion leaving the room are recorded, and, where required, measurements of the water heated by the appliance. Radiation from the appliance is measured in the room by thermopiles arranged on a travelling arc covering the hemisphere in which the appliance is placed centrally.

Constant-temperature conditions on the outside of the testing cabinets are obtained by controlled air circulation, and a refrigeration plant is also provided to give cool air, when atmospheric temperatures are high or when appliances with a high output of heat are being examined.

The flues taking the products of combustion from the room are lined with stainless steel to enable the soot deposited to be removed without contamination for weighing and analysis. The flues terminate below the roof of the building, and constant conditions are maintained at the exit by a cowl and an injector fan. The smoke content of the gases is measured by projecting a beam of light across the flue on to a photoelectric cell. Two separate light paths are used, one directly across the flue for dense smoke, and the other with an oblique path for the lighter smokes. Electrical supplies to the light projectors and the photo-cell amplifiers are specially stabilized so that the record is unaffected by variation of mains voltage or frequency. The double windows through which the beams of light pass are electrically heated to avoid deposition from the products of combustion. The photo-cell equipment is calibrated by direct determination of the concentration of smoke in the chimney gases.

The control room for the four testing rooms is on the first floor and is 52 ft. long by 10 ft. wide ; it is connected by air locks to each of the four rooms. All instrument readings are automatically recorded in the control room, each calorimeter room having its separate panel. The instruments include six-line recording potentiometers and controllers for the constant temperature chamber. Air-flow recorders are mounted underneath the inlet ducts in the control room. Equipment is also provided for the accurate control and measurement of the water supply for measuring the boiler output of appliances.

Laboratory and office accommodation, and fuel storage, are arranged in the building, which forms a complete unit.

The construction and design comprise many novel features, and the calorimeter building should provide more detailed and accurate information of the heat output of domestic appliances and thus point the way to improvements in methods of heating.

OBITUARIES

Prof. Jacques de Lapparent

PROF. JACQUES DE LAPPARENT, the eminent French lithologist, *Correspondant* of the Paris Academy of Sciences, died on May 18 at the age of sixty-five.

Jacques de Lapparent was educated in Paris. The enthusiastic interest which he displayed for minerals during his youth grew with time. The man thoroughly realized the vocation of the boy and, moreover, became a true scientific creator, a scholar backed by an artist.

As a university professor, J. de Lapparent was appointed to Lille in 1913, to Strasbourg in 1919, to Paris (Sorbonne) at the beginning of 1947. Since 1942, he also gave a regular course of geology and mineralogy at the École Centrale des Arts et Manufactures of Paris. His lectures were none the less in the classical style, and his original views and style brought together a select group of advanced students, chiefly in his later years.

Though he was a keen mineralogist and geologist, de Lapparent devoted the greatest part of his career to petrography and lithology. As a naturalist he gathered a great deal of information by travelling through many countries : Great Britain, Finland, Yugoslavia, Greece, French North Africa, French West Africa, and, of course, throughout France.

J. de Lapparent published about a hundred and twenty studies, including his authoritative and inimitable "Leçons de Petrographie", which established his world-wide reputation. Part of his reputation was due to some thirty published studies concerning bauxites and clays. He endeavoured to clear up the mineralogical composition and conditions of deposit of these rocks and earths. He was the first to show that three types of bauxite exist, each of them characteristic of geological phenomena at the age of formation : gibbsite bauxites formed above water-level, boehmite bauxites at water-level, and diaspore bauxites below water-level. Studying clays in a similar broad manner, he showed at the outset that fuller's earths are either kaolinite–halloysite earths, or attapulgite earths, or montmorillonite earths. These two last constituents, both aluminous and magnesian, are of different architectural types. Prof. de Lapparent endeavoured to elaborate an unequivocal classification with the aid of X-ray studies, which specify 7 A., 10 A., 14 A. as the structural spacings for phyllites. At the same time, with his usual well-balanced scientific sense of research, he explained the geological origin of some montmorillonite clays.

Indeed, Prof. de Lapparent was able to combine the keenest observation of the naturalist, either in the field or in the laboratory, by eye or with the aid of a microscope, with the ability to call upon modern physico-chemical techniques, to contribute to lithological problems. In this respect, it must be emphasized that, though he considered himself a naturalist, he was fully conversant with many physico-chemical methods, procedures and tests, X-ray crystallography being among the most helpful. He was able to grasp very easily the structural work coming from Sir Lawrence Bragg and his school and from Prof. L. Pauling. His aptitude for understanding in quite a short time the geometrical and physical aspects of atomic structures was really amazing. His efforts to introduce into petrography the results of structural X-ray crystallography, made with a pioneer's confidence, began to receive full appreciation in recent years.

J. de Lapparent wrote with a modern style—rather unusual, at least in French scientific papers—which sometimes gave a wrong impression to the reader more accustomed to a bald style supposed to be more fitted to scientific truth. The epigraph introducing one of his books was the famous quotation: "To everyone his own truth"; one of his works bears for title: "Defense de l'attapulgite".

Actually, J. de Lapparent strived to report with a vivid style changes in the earth's crust, because he was himself a living representation of these phenomena. Further, the reader cannot but be impressed by the longing for truth which inspires J. de Lapparent's works and to appreciate the essential synthesis which appears in them in various guises. Up to the end of his life, Jacques de Lapparent maintained his high standards and his enthusiasm. His loyalty to friends, his charming attitude to all his acquaintances without reference to their position, made him a most attractive personality.

R. J. HOCART

WE regret to announce the following deaths:

Mr. T. R. D. Bell, C.I.E., chief conservator of forests, Bombay Presidency, during 1909–20, on June 24, aged eighty-five.

Mr. Harry Brearley, Bessemer medallist of the Iron and Steel Institute in 1920, known for his work on stainless steel, on July 14, aged seventy-seven.

NEWS and VIEWS

Zoology at Belfast: Prof. T. T. Flynn, M.B.E.

PROF. T. T. FLYNN is to retire at the end of the present session from the chair of zoology at the Queen's University, Belfast, which he has held since 1931. Born in Australia in 1883 and trained at Sydney under W. A. Haswell and J. P. Hill, he developed a natural interest in the anatomy and embryology and reproductive phenomena in marsupials. He maintained this interest throughout his university career, making valuable additions to knowledge in this subject. So recently as 1941, in collaboration with J. P. Hill, fundamental agreement in the mode of formation of the primary germ layers in monotremes and marsupials was demonstrated, while in 1947 strong support was given for the view of a similar mode of formation in birds and an incentive predicated for the re-examination of germ-layer formation in reptiles in the light of the work portrayed. Along with his interest in marsupials and their nearer allies, Flynn contributed work on the Pycnogonida of South Africa, describing ten new species; on corals of the Barrier Reef; on the invertebrate fauna of Tasmania; on rare and fossil Cetacea; and he demonstrated his interest in marine biology as leader of the Australian Antarctic Summer Expedition 1912, and as sole Royal Commissioner for the Tasmanian Fisheries in 1915. In his retirement to Jamaica he hopes to utilize this latter experience in taking a serious interest in the marine biology and fisheries of the Caribbean area, as well as in meeting the demands of the British Museum for local biological material.

On graduating at the University of Sydney, Prof. Flynn was awarded the University Medal and John Coutts Research Scholarship; and later he received the University Medal for his D.Sc. thesis. He was Macleay Fellow of the Linnean Society of New South Wales in 1911, and Rockefeller Fellow during 1930–31; he was elected a member of the Royal Irish Academy in 1934. In the Second World War he was Chief Casualty Officer (Civil Defence), Belfast, and received the M.B.E. for his services. His many friends wish him a happy and fruitful retirement.

Baron Roland von Eötvös (1848–1919)

ON July 27 the centenary occurs of the birth of the distinguished Hungarian physicist Baron Roland von Eötvös, who in 1891 founded the Hungarian Mathematical and Physical Society and was long the president of the Hungarian Academy of Science. Both his grandfather and great-grandfather had held high office under the Austrian crown, and his father Baron Josef von Eötvös (1813–71) was at one time Minister of Public Instruction. Born at Budapest, the younger Eötvös was educated at the University there, but studied later under Kirchhoff, Helmholtz and Bunsen at Heidelberg, and under Franz Neumann at Königsberg. He became a *Dozent* in physics at Budapest, and in 1872, at the age of twenty-four, was appointed to the chair of theoretical physics, and later was transferred to the chair of experimental physics. Known widely for his invention of the torsion balance for the investigation of gravitational anomalies, he was recently referred to by Prof. A. O. Rankine as "the father of geophysical prospecting for oil, even if a hesitant one". He died at Budapest on April 8, 1919, at the age of seventy.

European Meteorological Telecommunications Panel

AN international conference was held in London during July 5–10 to consider the problems which confront European meteorologists in the exchange of weather information. The meeting took place under the auspices of the International Meteorological Organisation, which recently decided to establish a meteorological telecommunications panel under each of its six regional commissions. This was the first meeting of the panel for the European region, and it was attended by meteorologists and telecommunications experts from Belgium, Eire, France, Great

Britain, Italy, Netherlands, Norway (also representing Sweden), Poland and the Occupied Zones of Germany. Observers from the United States Weather Bureau and the International Civil Aviation Organisation were also present. Unhappily, the Danish delegate and his secretary were killed in an air collision over Northolt on the day before the conference opened.

In an address of welcome to the delegates the Secretary of State for Air referred to the growing importance of meteorology to economic problems, and he directed attention to the accuracy of modern weather forecasts—a fact which is frequently forgotten by the public, who tend to stress the occasional failures. Rapid dissemination of weather reports is vital to forecasting. Hitherto the international exchange of reports has been made primarily by wireless telegraphy, but in recent years high-speed teleprinters have been introduced to link several of the countries in western Europe. The conference discussed measures for increasing the efficiency of this international meteorological teleprinter network and for extending it to the countries of central and eastern Europe. For exchanging weather information between Europe and North America, high-speed radio teleprinters are to be used, although it will be necessary to retain a trans-Atlantic cable link as a standby for use when radio fade-outs render the radio-teleprinter channel inoperative. The conference recommended that Great Britain should provide the European terminal for these trans-Atlantic exchanges and should also be responsible for disseminating the American reports throughout Europe by wireless telegraphy and by the European land-line teleprinter network. Great Britain already transmits in high-power broadcasts from Rugby a 'European collective' message, which gives a selection of European weather reports and can be heard throughout the northern hemisphere.

Evolution of the Gene

PROF. A. H. STURTEVANT discusses one of the most pressing problems of biology in a recent issue of the *American Scientist* (34, 225; 1948). It has been a mystery how new heritable material for the production of new characters originates. When Harland, as the result of his work on cotton, concluded that homology of parts in related species is not correlated with the homology of genes which produce them, another reason was given for disbelief in the value of homology for biological analysis. Sturtevant challenges this view and points out that the polyploid nature of cotton permits the differentiation of two sets of genes in the amphidiploids after their creation. Hence, in one species, one set of genes may control some characters, leaving the other free for differentiation. In a different species the reverse takes place. Sturtevant compares the characters in different species of *Drosophila* and suggests that two organs are homologous if they are conditioned by homologous genes. This implies degrees of homology, since genes may vary from being identical (being allelomorphic mutants), partly homologous to non-homologous. Homology therefore becomes relational and amenable to mathematical treatment rather than absolute.

Sturtevant points out that in a diploid organism all the genes are functional in that the characters they affect are subject to selection. An alteration in any one of them will give rise to a new phenotype. Therefore these genes cannot be spared for other purposes. If, on the other hand, some genes are carried on duplications, these will be surplus to the requirement of the organism and could vary to wide limits without an immediate effect on the individual or even its progeny. He therefore sees a source for new hereditary material in the duplications which constantly occur in most, if not all, living organisms.

Hæmophilia in Dogs

F. B. Hutt, C. G. Rickard and R. A. Field (*J. Hered.*, 39, 3; 1948) describe the discovery of a sex-linked hæmophilia in dogs. This shows as a lameness and by swellings in various parts of the body when the puppy is six weeks old. Examination showed that the lameness was due to hæmorrhage at the joints. Of seventeen puppies which have been recognized as hæmophilics, not one has been raised to maturity. Several tests for hæmophilia in man were applied to these dogs and were found to give positive results. The breeding histories of the parents of the puppies were known; as a result, it was easily seen that the condition was due to a sex-linked recessive gene called *h*. The importance of the discovery lies in the fact that the comparative physiology of dog and man is well known, and the condition will be of value in research. It is noteworthy that this case in dogs is one of the few sex-linked genes in mammals other than man where seven or eight sex-linked characters are known. The pig has an inherited hæmophilia; but this is controlled by a recessive gene on an autosome. It is probable that paralytic or lame puppies which were destroyed in the past were in reality sometimes hæmophilic. It would be desirable to discover whether any hæmophilic puppies survive to maturity; on the different genetic backgrounds of different breeds, the recessive gene may not always have a lethal effect.

Uganda Forestry Department Report

THE report for the year ended December 31, 1946, of the Uganda Forestry Department has recently been issued (Govt. Printer, Entebbe. 1*s.* 6*d.*). The following quotation from a report on forestry in Uganda, by the late Prof. R. S. Troup in 1922, is given in an opening paragraph. "The percentage of timber forest in Uganda is very small compared with that of most timber-producing countries. . . . There does not, however, appear to be any real cause for alarm, provided the existing forest area is strictly maintained, and all accessible forests are brought under systematic management. . . . The preparation of forest Working Plans should be pushed on in all forests which are accessible to regular working. . . . Without Working Plans systematized work is impossible, and there is a strong risk of the forests being overworked and eventually rendered valueless." Uganda is one of the few departments in the Colonial Forest Services which has printed, published and circulated outside the Protectorate a working plan, with several others in hand. This plan is for the Budongo Forest and it undoubtedly saved that forest during the War. It has now been accurately revised for the second period of ten years, 1945–54. The Buganda Forests were exploited heavily during the War in the absence of a working plan, as in so many other parts of the British Empire and elsewhere in the world. The yield is now carefully controlled. The forest policy for Uganda is also being implemented by the systematic reservation of all main watersheds. This annual report shows that forestry and its requirements are thoroughly understood in Uganda.

Sugar Industry of the Caribbean

SUGAR still occupies the first place in Caribbean economy, despite the severe and growing competition in other parts of the world. The factors concerned with this economy are considered at length in "The Sugar Industry of the Caribbean", compiled by the Caribbean Research Council (Washington, D.C., 1947. Crop Inquiry Series No. 6). Some Caribbean territories have been unable to withstand competition and have given up sugar cultivation, whereas in others there has been an increase; but increase is most noted in production, not acreage. This has been greatly helped by research work on new varieties more resistant to disease, and the study of pests. Cane breeding is now active in Barbadoes, British Guiana and Puerto Rico. Experimental work with various fertilizers has had useful results, and there has been a great increase in the import of fertilizers. Sulphate of ammonia is the chief fertilizer. The estates without manure now form a minority. Another change in the industry of cane-growing is the increase in mechanization, especially in United States territories. Weeding and harvesting are still done largely by hand. Generally speaking, there is great scope for the use of more machinery as well as for the centralization of production.

Development of British Somaliland

THE report on the General Survey of British Somaliland, 1946, conducted under Approved Scheme D484, Economic Survey and Reconnaissance, under the Colonial Development and Welfare Act, records that the 1946 rainfall was higher than average and well distributed (British Military Administration, Burao, Somaliland. Pp. 20+12 pl. 6*s*.). Tribes tended to move more to south-west than south-east and not so far afield from the Protectorate as in the previous two years. This was due to better rainfall in and near the Protectorate, and resulted also in a drawing in of Somali tribes towards British Somaliland. Rainfall and tribal migration maps are appended to the report. Development of water supplies and some minerals should be possible in 1947–48, and if the survey is continued until the end of 1950, a more balanced report, based on the records of a seven-year cycle, should be possible and facilitate the making of definite proposals for developing the country.

Medical Progress in Chile

THE Medical Faculty of Valparaiso, formed after a meeting of Chilean medical men convened in March 1912, by Dr. Frederico Engelbach, has, since its formation, planned the publication of an official scientific journal; but for various reasons this has not been possible until this year. Now the first number of this vigorous Faculty's journal, *Revista Medica de Valparaiso*, has appeared. Well printed and tastefully produced, it will appear in February, May, August and November each year and will publish only scientific papers. As the Faculty's president, Dr. R. Gajardo Tobar, says in his editorial, its pages are dedicated to those who have studied phenomena with objective criticism and express their results with the greatest possible precision. The new journal will record the more important themes presented to the Faculty, summaries of the Faculty's meetings and articles by individuals invited to contribute. This first number contains articles on hypertension of nephritic origin, streptomycin and tuberculous meningitis, the therapeutic action of urethane in leukæmia, and varicose veins and their treatment. Medical men in both the Old and the New Worlds will welcome this new record of the work being done in Chile.

British Agricultural Bulletin

British Agricultural Bulletin is a new, illustrated quarterly journal published by the British Council. It is intended for overseas circulation, particularly with a view to the needs of agricultural administrators, university and agricultural college teachers, research workers and large-scale farmers, none of whom have time to digest the vast specialist literature of to-day. In the words of Prof. J. A. Scott Watson's editorial note, its aim is "to put British knowledge and experience at the disposal of the farmers and citizens of other countries" and thus to help them in their efforts to increase the world's food supply. The articles in the first number (Spring 1948) cover a wide field and are written by specialists on the subject in each case. General principles of animal improvement, war-time farming in Cheshire, the resting break in farming systems and new ideas in grain storage are discussed in some detail, while of more general interest is the account given of the aims and organisation of the National Agricultural Advisory Service set up in Britain in 1946. Reviews and advertisements of books form a prominent feature, and a special article in this number is devoted to modern English books on agriculture. In future issues, it is hoped to give some account of such new technical developments or scientific discoveries as seem ready for application to farm practice, and to discuss matters of agricultural finance, economics and education in terms intelligible to the layman. The price for four numbers will be 15*s*. (including postage), payable to the British Council, 3 Hanover Street, London, W.1.

Irish Chemical Association Summer School

A SUMMER School organised by the Irish Chemical Association and held in Dublin during July 5–9 attracted 130 participants, of whom some thirty came from universities, hospitals and industrial concerns in Great Britain. The courses covered recent advances in various branches of chemistry. Dr. V. C. Barry, research fellow of the Medical Research Council of Ireland, dealt with the subject of chemotherapy with particular reference to tuberculosis. During his lectures he discussed some of the results obtained by the active school in Dublin of which he is the head (see *Nature*, 160, 800; 1947). Lectures were given on recent advances in the technique of organic chemistry by Prof. W. Cocker, professor of chemistry, Trinity College, Dublin. The last lecture of this particular series was delivered by Mr. E. R. Stuart, Trinity College, Dublin, who surveyed the methods of application of infra-red and ultra-violet radiation to the determination of the structure of organic compounds. Prof. E. J. Conway, professor of biochemistry and pharmacology, University College, Dublin, who has recently returned from a lecture tour in the United States, discussed biological oxidation and reduction, the nature of the cell membrane and the chemical interpretation of the action of hormones and vitamins, and concluded his course with a lecture on the biochemical approach to carcinogenesis. Prof. T. S. Wheeler, professor of chemistry, University College, Dublin, in a course of five lectures, gave a simplified account of the mathematical background of wave mechanics and described the application of the wave theory to problems in inorganic and organic chemistry. The School was opened by Mr. Michael Tierney, president of University College, Dublin, who referred to the responsibility of the man of science for the uses, good and bad, made of his discoveries.

Physiology and Pathology of Animal Reproduction

At the final meeting on June 30 of the first International Congress of the Physiology and Pathology of Animal Reproduction and Artificial Insemination, which was held in Milan under the auspices of the University and of the Spallanzani Institute, a permanent committee was set up to organise within three years from now another congress on the subject. This committee is constituted as follows: J. Anderson (Kenya), Prof. T. Bonadonna (Italy), Prof. E. Garcia Mata (Argentina), Prof. R. M. C. Gunn (Australia), Dr. J. Hammond (Great Britain), Prof. N. Lagerlof (Sweden), Prof. G. Lesbouyries (France), Prof. B. B. Morgan (United States), Prof. E. Sorensen (Denmark). Prof. N. Lagerlof has been elected president and Dr. Hammond and Prof. Sorensen vice-presidents. Prof. T. Bonadonna, of Milan, secretary general of the first Congress, has been appointed secretary of the committee.

Revue Générale du Caoutchouc

"Rubber Developments" reports that arrangements have been made whereby the old-established monthly journal, *Revue Générale du Caoutchouc*, can be more readily obtained in Great Britain. Recently, the journal has been improved in make-up, and a welcome feature now is the inclusion of summaries in English of the more important articles. Specimen copies of the journal, subscription forms and further information can be obtained from the Secretary, British Rubber Development Board, Market Buildings, Mark Lane, London, E.C.3.

Earthquakes during March and April, 1948

There were at least nineteen strong earthquakes in the world during March, and at least seven during April. The strongest shock during March was probably that of March 3 from an epicentre near lat. 18° N., long. 119° E. off the north-west coast of Luzon, Philippine Islands. It gave ground amplitudes of 160 μ at Kew. The second strongest was on March 1, from an epicentre near lat. 3° S., long. 130·5° E., off the west coast of New Guinea. This gave ground amplitudes of 80 μ at Kew. The deepest shock during March occurred on March 23 from an epicentre near lat. 51° N., long. 155° E., off the southern coast of Kamchatka. The depth of focus was between 200 and 250 km. The only great shock on land was on March 27, when a severe earthquake shook the city of Sucre in Bolivia, causing considerable damage to property, including the cathedral, plunging the city into darkness and cutting off communications with the rest of Bolivia; only three casualties have been reported. An earth tremor on March 16 was felt at Lourdes, Argeles and Bagnères; but no damage is reported. There were no great earthquakes on land during April. The greatest earthquake during April was that on April 21 from an epicentre near lat. 19° N., long. 69·5° W., off the north-east coast of the Dominican Republic, and the deepest (200 km.) was on April 12 from an epicentre near lat. 14° N., long. 90·5° W., off the coast of Guatemala. Reports for these months have been received from the International Bureau at Strasbourg, the Jesuit Seismological Association, the U.S. Coast and Geodetic Survey and the following individual observatories: Cleveland (Ohio), Beograd, De Bilt, Durham, Kew, Stuttgart, Toledo, Uccle, Zurich and the Swiss stations.

Colonial Services: Appointments

The following appointments in the Colonial Services have been announced: R. Wilcox, inspector of mines, Malaya; L. St. Clair Bartholomew, fisheries officer, Uganda; Miss E. B. Cheek, biochemist, Institute of Medical Research, Malaya; D. H. Constable, soil survey officer, Trinidad; J. Fleming, inspector of plants and produce, Nigeria; Miss R. M. Lowe, fisheries research officer, Uganda; L. J. S. Littlejohn (botanist and plant pathologist, Cyprus), soil conservation officer, Cyprus; P. O. Wiehe (plant pathologist, Mauritius), plant pathologist, Nyasaland; J. A. N. Burra (assistant conservator of forests, Palestine), assistant conservator of forests, St. Lucia, Windward Islands; A. B. Walton (senior assistant conservator of forests, Federation of Malaya), conservator of forests, Federation of Malaya; R. J. S. Waddington (inspector of mines, Tanganyika), senior inspector of mines, Tanganyika; J. W. Loxton (superintendent of surveys, Palestine), staff surveyor, Kenya; R. W. Crowther (veterinary officer, Nigeria), veterinary officer, Cyprus; C. M. Anderson (livestock officer, Tanganyika), senior livestock officer, Tanganyika; C. J. Buckley (livestock officer, Tanganyika), senior livestock officer, Tanganyika; J. W. T. Holloway (livestock officer, Tanganyika), senior livestock officer, Tanganyika.

The appointment of J. I. Moggridge (*Nature*, April 24, p. 637) should read "director, Tsetse Control Department, Uganda".

Announcements

The Lister Medal for 1948 has been awarded to Prof. Geoffrey Jefferson, professor of neuro-surgery in the University of Manchester, in recognition of his contributions to "knowledge of the functions and structure of the nervous system, made as a Philosophical Biologist, practising Neuro-surgery". Prof Jefferson will deliver the Lister Memorial Lecture in London in June 1949, under the auspices of the Royal College of Surgeons of England. This is the ninth occasion of the award, which is made by a committee representative of the Royal Society, the Royal College of Surgeons of England, the Royal College of Surgeons in Ireland, the University of Edinburgh and the University of Glasgow.

Dr. J. T. Edwards, who was invited in 1946 by the Egyptian Government to advise on veterinary education in that country, has been awarded the Order of the Nile (Third Class). Not only was Dr. Edwards able to give valuable service to the veterinary schools, but also he devised measures for combating an outbreak of cattle plague which threatened to become a national disaster.

Prof. W. Sierpinski, of the University of Warsaw, and Prof. F. Riesz, of the University of Szeged, have been elected *Correspondants* for the Section of Geometry of the Paris Academy of Sciences.

We have received from Messrs. Johnson, Matthey and Co., 73–83 Hatton Garden, London, E.C.1, a catalogue of chemical compounds of the precious and other metals. This contains the names of many compounds of rare metals as well as those of commoner elements, and standard metals of high purity for spectrographic work.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Unit Cell Measurements of Wet and Dry Crystalline Turnip Yellow Mosaic Virus

CRYSTALS of turnip yellow mosaic virus, kindly sent to us by Dr. Kenneth Smith and Dr. Roy Markham (see *Nature*, July 17, p. 88), were examined both optically and by X-ray diffraction in this Laboratory. The crystals were small, isotropic, less than 0·1 mm. in size and ill-formed, but just sufficiently developed to indicate that they were octahedral bipyramids. The smaller crystals, first observed by Smith and Markham under a 1/12 oil immersion lens[1], are better formed and display a better development of this form. Following Federov's law on the relation between lattice development and crystal form, these crystals should possess a face-centred lattice.

Powder photographs were taken of the wet crystals, in sealed thin-walled borosilicate tubes containing mother-liquor, with copper $K\alpha$ rays obtained by crystal reflexion from pentaerythritol. From photographs taken at specimen-film distances of 30, 35 and 40 cm., the following spacings were recorded : 407 A., 250 A., 211 A., 175 A., 147 A. and 83 A. The spacings observed fit a face-centred cubic lattice with side equal to 706 ± 11 A., and the following reflexions are accounted for : 111, 220, 311, 400, 422 and 660, with a notable absence of the 222 reflexion, suggesting, therefore, that the virus particles are arranged in a diamond type lattice. There must be eight molecules per cell in such a lattice, giving an interparticle distance of 306 A. or 30·6 mμ.

The powder photographs of virus, dried over phosphorus pentoxide and taken at 30-cm. specimen-film distance, have not yielded the same number of reflexions ; there being present a strong reflexion at 190 A. and indications of a weak one at about 310 A. In the case of the wet crystals the 220 is the strongest reflexion, and if we assume that this is the same for the dried crystal this gives us a face-centred lattice of side 528 A.

Markham[2] has also sent us crystals that are nucleic acid-free and non-infective, which were obtained from the top layers of centrifuged solutions of the virus. The crystals in this case were smaller in size, but showed the same morphological development and optical properties. A noticeable feature here was the longer exposure time needed (144 hours as compared with 96 hours for the virus crystals) to give even an indication that a low-angle diffraction pattern could be obtained. The low-angle diffraction pattern, although weak, was found to be nearly identical in the measurement of spacings with that of the virus crystals containing nucleic acid. The high proportion of nucleic acid in the virus crystals must contribute effectively to the observed reflexions for the virus crystals, and so it is open to question at this stage whether the intensities of the corresponding reflexions in the two types of wet crystals are the same. This can only be settled with examination of bigger crystal specimens. The measurements, however, from the observed spacings for the wet and dry nucleic acid-free crystals gave cell sides of 725 ± 25 A. and 550 A. respectively. The reliability of these measurements is not as high as that for the virus crystals ; but as they stand, the measurements would seem to indicate a slightly larger nucleic acid-free molecule than that containing nucleic acid. For practical purposes, however, one might at this stage assume the same size of hydrated molecule in both the infective and non-infective crystals.

This naturally raises the question of the location of the nucleic acid in the infective crystals. The X-ray evidence by itself at this stage is far too meagre to make any statement about it. It may be situated within the molecule or possibly on those surfaces of the molecule not exerting attractions between the tetrahedrally distributed neighbours. If the differences in cell-size measurement are significant, it might be possible that the nucleic acid in some manner holds the molecule in a tighter mass with the same attractive surfaces remaining unaffected. These questions can only be answered when it becomes possible to compare the wide-angle diffraction patterns of the two types of crystal.

It is most probable that in both types of macroscopic crystal the diamond-type lattice is retained on drying. On observation under the microscope, the virus crystals (those containing nucleic acid) have been observed to shrink homogeneously by about 15 per cent ; the earlier part of this shrinkage being reversible. If the diamond lattice is retained, the interparticle distance would be 228 A. (or 22·8 mμ) for the dried virus crystals, and 238 A. (or 23·8 mμ) for the dried nucleic acid-free crystals. Cosslett and Markham, in studying both types of virus aggregated on the electron microscope, support an open packing corresponding to the projection of a diamond lattice on the (110) planes with an interparticle distance of 19·3 mμ for the virus crystals[4].

On the basis of this evidence, it would appear that the interparticle distance of both types of protein can alter on drying by as much as 76–78 A. The nucleic acid apparently has no effect on the forces holding the particles together in either the wet or the dry crystals. A shrinkage of this extent has been found already in the case of tobacco mosaic virus, where at the isoelectric point the interparticle distances change[3] on drying from 175 to 152 A. There is, however, a fundamental difference between these two cases : the tobacco mosaic virus is one of close-packed long rods, whereas in the turnip yellow it must consist of iso-dimensional molecules. Now the change between the wet and dry state of the tobacco mosaic virus is not accompanied by any noticeable alteration of the internal structure of the virus particle. If we make the same assumption for the turnip yellow virus—and this would also be in accord with all recent work on protein structure, particularly that of Perutz—this would imply that in the crystal in its wet state the molecules are separated by a distance of 78 A. of water. The indication is that the individual molecule has a markedly differentiated surface of tetrahedral symmetry, having four faces with a greater affinity for similar faces in other molecules than has the rest of the surface.

Perutz[4] believes that in the case of hæmoglobin there is a layer of 'bound' water attached to the surface of the molecule. Let us make the assumption for simplicity that the virus particle is spherical in shape and that in the wet crystal it is surrounded by a layer of water. Markham has observed that the partial specific volume of the particle is 0·685 and the density of the wet crystal is 1·33 (in sodium thiosulphate)[5]. A simple calculation from these figures, using the X-ray data as well, shows that the unhydrated particle must have a diameter of 206 A.; meaning, therefore, that there is a layer of water some 11 A. thick surrounding the particle in the wet crystal. This thickness compares rather favourably with the difference in interparticle distances as measured directly by X-rays and by the electron microscope: 228 A. by X-rays, 193 A. electron microscope[6]. The volume of the cell not occupied by the hydrated molecules in the wet crystal is therefore about 86 per cent, which is somewhat greater than the 76 per cent found by Markham for crystals in ammonium sulphate solution; but as we do not know the exact shape of the virus particles the discrepancy between these figures would imply that the particles are not likely to be spherical in shape. A tetrahedrally desegmented sphere, for example, with the same interparticle distance would give a larger volume.

Similar calculations have been carried out for the nucleic acid-free particles. Here Markham has found that the partial specific volume is 0·75 and the density of the wet crystal is 1·305 (in sodium thiosulphate)[5]. If we assume for the moment that the interparticle distance as measured from the dry crystal is the same as that for the dried virus crystals, then the calculations show this time that the nucleic acid-free particle is surrounded by a layer of water some 3 A. thick. In other words, the unhydrated nucleic acid-free particle has a bigger volume than the unhydrated virus particle. We have been informed by Cosslett (unpublished data) that measurements on electron micrographs of the nucleic acid-free material indicate, within experimental error, a particle that is larger than that observed by them for the virus. This seems to be borne out also by the X-ray measurements on the dried nucleic acid-free crystals, but as mentioned previously, we cannot claim sufficient accuracy for this last measurement.

It would be rash at this stage to speculate too freely on the question as to the location of the nucleic acid in the virus molecule from the few observations that have been made to date; but the evidence, scanty as it is, seems to point to the fact that the nucleic acid-free particle has a larger volume than that containing the nucleic acid. This appears to be a paradox—that something containing additional material should occupy a lesser volume than the same thing without the material! The paradox might be resolved by the suggestion that the nucleic acid draws the protein material of the non-infective particles into a smaller volume. Such a suggestion would not be out of keeping with the findings of many workers that it is extremely difficult, in most cases, to separate completely the nucleic acid from the plant viruses, as, for example, in the case of tomato bushy stunt virus.

We still cannot say anything about the shape of these particles. Whatever their shape, however, the force of attraction holding them together must be acting over relatively large areas of the particle which must come into near contact when the crystal dries, and these surfaces can be separated by 78 A. thickness of water containing ions and yet give the structure considerable rigidity. Similar layers of water have been observed in protein crystals; but the largest recorded thickness is 11 A. in hæmoglobin[3]. The importance of these observations is that they demonstrate at the same time a definite external complexity of virus protein and the possibility of maintaining equilibria at long distances in aqueous solution for bodies other than a plate or rod-like shape where it has been previously observed.

J. D. BERNAL
C. H. CARLISLE

Birkbeck College Research Laboratory,
21–22 Torrington Square,
London, W.C.1. July 9.

[1] Markham, R., and Smith, K. M., *Nature*, **157**, 300 (1946).
[2] Markham, R., Matthews, R. E. F., and Smith, K. M., *Nature*, **162**, 88 (1948).
[3] Bernal, J. D., and Fankuchen, I., *J. Gen. Physiol.*, **25**, 111 (1941).
[4] Boyes-Watson, J., Davidson, E., and Perutz, M. F., *Proc. Roy. Soc.*, A., **191**, 83 (1947).
[5] Unpublished data.
[6] Cosslett, V. E., and Markham, R., *Nature*, **161**, 250 (1948).

An Optical Analogue of X-Ray and Electron Diffraction Patterns

THE bubble model developed by Bragg and Nye[1] gives a pictorial representation corresponding, with a high degree of probability, to the arrangement of atomic sites within a crystalline material. In order, however, to make further progress with the help of this model, it is desirable to produce an experimental technique which will enable some correspondence between the bubble model and the actual degree of order in the crystal to be established.

Perhaps the most convenient method of exploring the regularity of a crystal lattice is by means of X-ray or electron diffraction. With this in mind, some preliminary experiments were performed with bubble rafts made with the help of the Physical Metallurgy Section of this laboratory.

The rafts were photographed on to 35 mm. film at such a reduction that individual bubble images were about 0·2 mm. in diameter. Illumination was by means of two 'Photoflood' lamps symmetrically arranged. The (negative) image of each bubble thus consisted of a thin dark ring enclosing an almost transparent disk which had two dark points (the direct images, by reflexion) of the lamps superimposed on it.

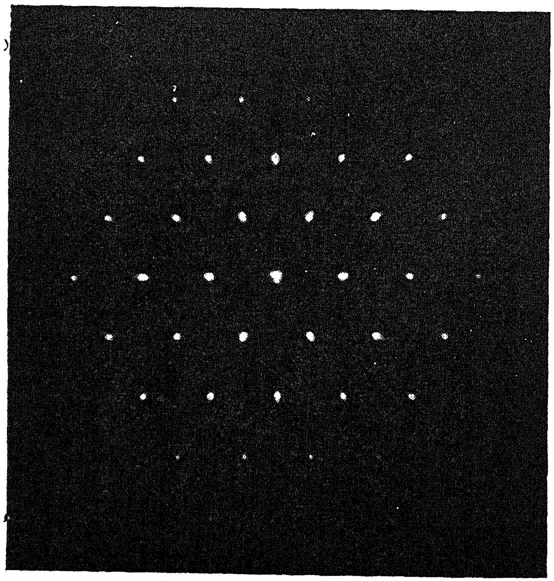


Fig. 1. DIFFRACTION PATTERN FROM PERFECT LATTICE

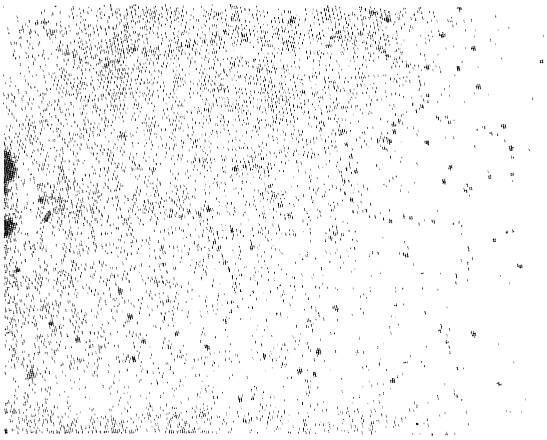


Fig. 2*a*. POLYCRYSTALLINE BUBBLE RAFT

The individual bubbles are not well shown, due to interference with the half-tone dots. Boundaries of crystal grains may be seen; also most of the dislocations may just be perceived as short dark lines

The developed film was then placed in an optical system which was, in effect, a spectroscope. Light from a pinhole approximately 0·10 mm. in diameter was rendered parallel by a collimating lens of about 35 cm. focal length; it then passed through the film and was observed in a telescope. The light source used was a B.T.H. 250-watt mercury vapour lamp with an Ilford 'Mercury Green' filter.

Each bubble image acts as a scattering centre and diffracts light with a polar diagram depending on its geometry and contrast. Interference between wavelets diffracted from the whole array of images gives a Fraunhofer diffraction pattern corresponding to that given by X-rays or electrons diffracted from a single sheet of atoms.

The pattern given by a perfect lattice is shown in Fig. 1. The photograph gives but a poor impression of the beauty of this pattern, which is especially great if the unfiltered light of the mercury lamp is used. In these circumstances each spot, save for the central one, becomes a short spectrum oriented in a radial direction.

Fig. 2*b* shows the pattern due to the polycrystalline raft shown in Fig. 2*a*. This raft was photographed immediately after growth, and consists of a few relatively large crystals with a certain amount of internal strains and dislocations. As might be expected, the pattern consists of 'spotty' rings, each spot being due to an area of almost perfect lattice. In addition, however, a certain amount of continuous background is evident. This is due in part to scattering from the photographic emulsion, but also in part to diffraction from the small amorphous portions around the grain boundaries.

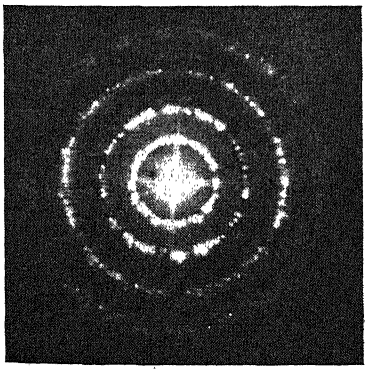


Fig. 2*b*. DIFFRACTION PATTERN FROM RAFT ILLUSTRATED IN FIG. 2*a*

The four white arms at right angles in the centre are due to diffraction from the edges of the rectangular aperture used in forming the diffraction pattern in this case

The patterns derived by this technique are more closely related to those obtained by electron diffraction than by X-rays, as in the former case diffraction is due only to a few atomic layers. Fig. 1 bears a close resemblance to the cross-grating pattern obtained by diffraction of electrons through a very thin sheet of mica.

Further work is being undertaken with the object of improving the resolution and illumination of the diffraction patterns.

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[1] *Proc. Roy. Soc.*, A, **190**, 474 (1947).

Discrete Sources of Galactic Radio Frequency Noise

IN a recent communication[1] an outline was given of investigations of the variable galactic noise received from the constellation of Cygnus, first noticed by Hey, Parsons and Phillips[2]. The characteristics of the radiation were described, and evidence was given of its origin in a discrete source. A search has since been made over about one quarter of the celestial sphere for other such sources. The region investigated is roughly enclosed by the co-ordinates:

R.A. 8 hr., Dec. + 40°; R.A. 21 hr., Dec. + 40°;
R.A. 4 hr., Dec. − 40°; R.A. 17 hr., Dec. − 40°.

The frequency used was 100 Mc./s., with an overall sensitivity of 10^{-24} watts m.$^{-2}$ (c./s.)$^{-1}$, and the technique and equipment employed were as previously described[1,3].

So far, six new sources have been found. They are listed in the accompanying table together with the

SOURCES OF GALACTIC RADIO FREQUENCY NOISE KNOWN TO FEBRUARY 1, 1948

Temporary designation	Position		Intensity at 100 Mc./s. (watts m.$^{-2}$ (c./s.)$^{-1}$)	Angular width	Type
	R.A.	Dec.			
Cygnus *A* (1·46)	19h. 59m.	+41° 47′	6×10^{-23}	< 8′	Variable
Taurus *A* (2·47)	5h. 13m.	+28°	10^{-23}	< 30°	Probably long-period variable
Coma Berenices *A* (4·47)	12h. 04m.	+20° 30′	$1·5 \times 10^{-23}$	< 15′	Constant
Hercules *A* (7·48)	16h. 21m.	+15°	2×10^{-24}	< 1°	—
8·48	—	—	2×10^{-24}	—	Constant
5·47	—	—	3×10^{-24}	< 1°	Constant
Centaurus *A* (6·47)	—	—	10^{-23}	< 15′	Probably Cygnus-type variable

source in Cygnus. The positions of three of the sources of northern declination have been computed from the experimental time-elevation curves using the first 20° rise above the horizon. There is an uncertainty of about 1° in the positions given. The source 8·48 rises only shortly before Taurus *A*, and the lobe pattern is then obscured by the stronger source. Similar overlapping of the Centaurus and 5·47 sources has so far prevented their accurate location.

The majority of these sources appear to be in regions of relatively low noise-brightness and star-density. It may be, however, that regions of high noise-brightness are regions of high source-density, not suited to resolution with the present technique. As in the case of Cygnus, the new sources do not appear to be associated with outstanding stellar objects.

The discovery of these discrete sources raises the question of the origin of galactic noise. Henyey and Keenan[4] proposed a mechanism of free-free electron transitions in ionized interstellar matter, with a free space electron temperature of 10^4 ° K. Townes[5] has pointed out divergences between theoretical calculations on this basis and experimental results for the maximum apparent temperatures of the Milky Way, particularly above wave-lengths of two metres. Moxon[6] has shown that the minimum apparent temperature (that is, at the galactic poles) varies as λ^2, whereas the temperature along the Milky Way, after subtraction of the polar residual, depends on λ^3—suggesting a twofold origin. Recent research on solar radiation at metre wave-lengths indicates that radiation from the quiet sun corresponds to a temperature of 10^6 ° K. and is presumed due to thermal emission from the corona. During times of sunspot activity, however, there is evidence that the apparent temperature may exceed 10^{10} ° K. for long periods and be even higher for periods of about a minute.

It is therefore not unreasonable to expect a measurable aggregate of emissions from individual stars in regions of high star-density, despite the large dilution factor. Moreover, it is likely that the free-space electron temperature is greater than 10^4 ° K. in the neighbourhood of *B*- and *O*-class stars.

On the basis of the present observations, it is suggested that the factors contributing to the observed intensity and distribution of galactic noise are threefold.

(1) A 'base-level' due to free-free transitions as proposed by Henyey and Keenan.

(2) An aggregate of emissions from individual stars in regions of high star-density.

(3) A contribution from individual discrete sources, which may be distinct 'radio-types' and for which a place might have to be found in the sequence of stellar evolution. Purely electromagnetic disturbances as an origin of these have been discussed by several writers[2,9,10], and the following additional possibilities are envisaged: (*a*) A pre-main sequence model consisting of a large cool gas sphere, gravitational energy of contraction being radiated in the radio frequency spectrum. (*b*) A post-main sequence model—possibly a development of the planetary nebula consisting of an intensely hot central star, with its radiation in the far ultra-violet, surrounded by a shell of predominantly stripped atoms.

I wish to acknowledge the assistance of Messrs. G. J. Stanley and O. B. Slee in making observations involved in this work, which forms part of the research programme of the Division of Radiophysics, Council for Scientific and Industrial Research, Commonwealth of Australia.

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Division of Radiophysics,
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Australia.
April 6.

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Electric Conductivity of the Ionospheric *D*-Region

RECENTLY, Cowling and Borger[1] have put forward theoretical reasons why the electric conductivity of the ionospheric *D*-region may be considerably less than that of the combined *E*–*F*-regions. On the further postulate that tidal motions increase with height in the ionosphere, they conclude that a recent deduction[2] concerning the origin of the solar and lunar magnetic variations is improbable.

There are two lines of reasoning, both mainly based on experimental evidence, which are difficult to reconcile with Cowling and Borger's conclusion. In the first place, it would appear very doubtful that tidal motions increase with height in the ionosphere. The height gradient of tidal motion depends profoundly on the temperature gradient in the ionosphere, and account must also be taken of the damping due to kinematic viscosity and to conductivity (both thermometric and electric). This damping alone must eventually cause a reduction of motion with increasing height. These considerations are supported by recent experimental evidence[3] that the solar tidal air motion is considerably greater in the *E*-region than in the *F*-region. (The much smaller solar tidal influence on *E*-region ionization is due to the much greater rate of ion production and recombination there.)

Again, recent experimental evidence[4] shows that the phase of the lunar tide in the *E*- and *F*-regions is substantially in opposition to that required to produce the lunar magnetic variations. This suggests strongly that these are produced mainly below the *E*–*F*-regions, and hence that the conductivity there is adequate.

Another argument against Cowling and Borger's conclusion is McNish's experimental evidence[5] that solar flares produce an enhancement, but little change in form, in the solar magnetic variations. It is known that such flares produce negligible changes in ionization in the *E*–*F*-regions, but notable changes in ionization below the *E*-region. Since it is most unlikely that a sporadic disturbance like a solar flare would cause an enhanced air motion identical in form with the regular solar tide, it seems very probable that the main part of the solar magnetic variations is produced below the *E*-region.

Nevertheless, while the weight of experimental evidence strongly suggests that the main part of the magnetic variations is produced below the E-region, it is important to reconcile this conclusion with Cowling and Borger's valuable discussion of the relatively small theoretical conductivity likely to be found there. In this connexion the results of an earlier investigation by Cowling[6] may be important. He showed that the conductivity of an ionized medium can become almost independent of the magnetic field if polarization is set up by the Hall current. In the earth's atmosphere the Hall current is produced by the differential motion of ions and electrons across the earth's magnetic field under the influence of the atmospheric tide. Calculation shows that if polarization adequate to equalize the velocities of ions and electrons is set up, then the effective conductivity of levels below the E-region will be increased by factors of the order 10^2–10^3.

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April 27.

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WE have recently begun to investigate theoretically how atmospheric tidal motions should vary with height above the E-layer. The work is still in the exploratory stage, and too great reliance cannot be placed on the tentative results which have so far been obtained. These results, however, suggest that tidal motions should increase with height for some considerable way above the E-layer. Considerable phase-changes may also occur above the E-layer. Such results are difficult to incorporate into a general theory of the magnetic variations, and we do not claim to be able to do so: but Dr. Martyn's interpretation of the facts need not be the only possible one.

Dr. Martyn's final suggestion will, unfortunately, not wholly resolve the difficulties to which we directed attention. Polarization counters the magnetic reduction in conductivity fully only if the Hall currents are completely prevented from flowing, and in this case the polarization field must considerably exceed the original field which makes it arise. If, say, the Hall currents in the ionosphere were vertical, the polarization produced by accumulations of charge above and below the conducting layer would be only slowly dissipated, and would be able to build up to a size sufficient to produce the desired effect. But normally the polarization electric field has a horizontal part, which makes the polarization charges leak away as fast as they collect. Hence, while polarization may partially restore the reduction in conductivity due to the magnetic field, it cannot do so more than partially.

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Electromagnetic Level-Shift and Effect of Radiation Field

THE brilliant experiment of Lamb and Retherford[1] has conclusively demonstrated that in the hydrogen atom the $2S$-level is higher than the $2P_{1/2}$-level by about 10 megacycles, a result which reveals a breakdown of the Dirac equation of the electron when applied even to the simplest of the atoms. In a fundamental paper, Bethe[2] has given an explanation of the observed level-shift on the assumption that the transverse self-energy of the electron, in general, depends on the state in which the electron is.

The observed level-shift and Bethe's theory are likely to prove of considerable significance in astrophysics. It is to be observed that the shift in the Balmer lines arising on the above account is comparable to the Einstein solar red-shift. Again, because of the separation between the $2S$- and $2P_{1/2}$-levels the possibility, arising on account of the Stark perturbation, of the (forbidden) transition $2S \rightarrow 1S$, is severely restricted; that is, the $2S$-state would behave as a metastable state, a behaviour which would not have been possible if the levels $2S$ and $2P_{1/2}$ were coincident as demanded by the Dirac equation. The metastable $2S$-state would obviously have an influence on the hydrogen chromosphere. Further, in astrophysical applications, in determining level-shifts, account must be taken of the radiation field surrounding the atom.

It can readily be shown that the transverse self-energy of a free electron is affected by the radiation field, and in the case of temperature equilibrium the increase in the self-energy of the electron is given by

$$\frac{1}{137}\;\frac{\pi}{6}\;\frac{kT}{mc^2}\;kT,$$

where m is the electron rest-mass, k the Boltzmann constant and T the temperature. In the case of atomic levels, the effect of the radiation field becomes complicated (because of the infra-red catastrophe). The details of this investigation will be published elsewhere.

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The Proof of Wien's Law

A VITAL step in the proof of Wien's Law, $E(\lambda,T) = T^5\psi(\lambda T)$, for complete radiation, is the adiabatic change in volume of a cavity filled with radiation. In Wien's first proof (1893)[1] and in the more analytical version of it given by O. W. Richardson[2], the cavity is cylindrical in shape and is provided with a movable piston. In order that the distribution in direction may remain random during the expansion, Wien stipulated that the cavity walls should be "perfectly white" (that is, diffuse rather than specular reflectors).

Larmor (1900)[3] pointed out that the proof is simplified if the shape of the cavity is taken to be spherical; the wave-lengths of all components are then altered in the same proportion. It is not, however, obvious that the distribution in direction is maintained during the expansion if the internal spherical surface is perfectly reflecting. Westphal

(1914)[4] makes the walls of his spherical cavity "white", possibly because of Wien's prescription of white walls for the cylindrical cavity.

Though Larmor's proof has been given in extended form in current texts, it appears not to have been demonstrated that, in the case of a spherical reflecting cavity, the change of angle with the normal which ensues on reflexion at the moving surface is compensated by the change of radius between reflexions. If i, θ are angles of incidence and reflexion respectively as the surface moves slowly outwards with speed dr/dt, $\theta - i = (2 \sin \theta /c)dr/dt$. The angle of incidence i' at the succeeding reflexion satisfies the equation $\sin \theta / \sin i' = 1 + dr/r$, where $dr = (2\, r \cos \theta /c)dr/dt$.

Thus $\sin i' - \sin \theta = -(2 \sin \theta \cos \theta /c)dr/dt$, and $i' - \theta = -(2 \sin \theta /c)dr/dt$, giving $i' = i$.

The angle of incidence remains the same at successive reflexions, and we may consider as a distinct group the radiation which is incident at angles between, say, θ and $\theta + d\theta$. If, at some temperature, $u_\theta d\theta$ is the energy density of the group in the immediate neighbourhood of the wall, and u represents the total energy density, it can be shown that $u_\theta = u \sin \theta$, while the pressure due to the group on the wall is $u_\theta \cos^2 \theta \; d\theta$ and the energy of the group in the whole sphere is $U_\theta d\theta = 4\pi r^3 u_\theta \cos^2 \theta \; d\theta$. The energy equation for the group in expansion is then:

$$dU_\theta + 4\pi r^2 u_\theta \cos^2 \theta \;.\; dr = 0,$$

whence

$$r du_\theta + 4 u_\theta \, dr = 0.$$

Comparing this with the equation for the whole radiation

$$r du + 4u \, dr = 0,$$

it is seen that the energy of each group is altered in the same proportion during the expansion, and the distribution in direction is maintained.

Wien (1894)[5] showed that this was true for a group at nearly normal incidence ($\theta = 0$); but the general case appears not to have been discussed. Larmor inserted a material particle in his cavity in order to maintain normal distribution in wave-length; but it is not clear from his argument, which is couched in very general terms, that the calculation of the change of wave-length from the Doppler effect is valid when the particle is present. Planck[6] has shown that for a cavity of any shape, the distribution in wave-length remains normal whether the small material particle is present or not; his demonstration of this, like the proof given by Wien for a cylindrical cavity, is valid only if random distribution in direction is maintained. The spherical reflecting cavity, without a material particle, thus provides a satisfactory proof when supplemented by the demonstration above of the maintenance of random direction and by Planck's proof of the maintenance of the distribution in wave-length.

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Photo-electric Star-following Telescopes

EXPERIMENTS have recently been conducted by the Telecommunications Research Establishment at the Royal Observatory, Greenwich, to investigate the automatic guiding of an astronomical telescope on a star. The work was done on the 13-in. astrographic refractor and the degree of success achieved was as follows.

In June 1947, using a very sluggish servo system, that is, one with a natural frequency of the order of 1/10 cycle per min., the steady state error in follow was less than 1″ (corresponding to an image movement of 0·001 in.).

The irregular refraction of the atmosphere causes the apparent direction of a star to vary at frequencies up to at least one cycle per second. Accordingly, a system with a more rapid response was built. In January 1948, using a servo system with a natural frequency of the order of ½ cycle per sec., there was a random steady state error of some few seconds of angle, owing to the larger band-width.

The servo system derives its 'knowledge' of misalignment from an error detection device comprising a graticule in the focal plane of the telescope, and in the form of a disk divided into equal sectors alternately opaque and transparent. The image of the star being followed is made to describe a circle over the face of the disk. Behind the disk is a photo-cell which collects the transmitted light in the form of pulses. When the telescope is aligned on the star, the circle of movement of star image is concentric with the disk and the pulses of transmitted light are of equal duration and separation; but when the circle of image movement is eccentric due to relative movement between star and telescope, the pulses then transmitted are effectively modulated in frequency. The amplitude and phase of this modulation give a linear measure to a first order of the telescope misalignment in magnitude and direction. The misalignment signal controls the acceleration of a servo motor which drives the telescope.

Since the astrographic telescope at Greenwich has a fixed plate-holder, guiding is possible only in right ascension; hence only one rectangular component of the misalignment information is required and used.

Consideration is now being given to the use of this or a similar system to guide automatically the 100-in. Isaac Newton telescope planned for erection at Herstmonceux.

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Presence of Cobalt in the Anti-Pernicious Anæmia Factor

INDEPENDENT investigation here and in the United States led to the recent isolation of the anti-pernicious anæmia factor as red needle-shaped crystals[1–3]. Examination of its ash has now unexpectedly revealed the presence of cobalt.

In four separate batches of crystals we have detected cobalt by the characteristic cobalt blue borax bead and by the specific red colour reaction with nitroso *R* salt. Colorimetric estimations with α-nitroso-β-naphthol showed the presence of 4·0 per cent of cobalt in crystals dried *in vacuo* at 56° C. If each molecule contains one atom of cobalt, the molecular weight of the compound is about 1,500 ; allowance for 8 per cent loss on drying brings the value to 1,600, in excellent agreement with that of 1,550–1,750 for air-dried material which Dr. Dorothy Crowfoot (private communication) has found by X-ray crystallography. (The uncertainty is due to the amount of available material having been inadequate for accurate determination of density.) The value does not agree with about 3,000, which we found by the diffusion method. The discrepancy may be due to errors inherent in this method or to the use of impure material in the earlier experiments, but it is also possible that association occurs in solution.

So far as we are aware, the presence of cobalt in an isolated compound of natural origin has not been previously reported, although cobalt is recognized as an essential trace element. It has been shown to prevent or cure in ruminants a syndrome involving anæmia and arising from feeding on pastures deficient in cobalt[4].

In discussion with Dr. Randolph T. Major, of Merck and Co., Inc., we have been informed that the Merck workers have also discovered the presence of cobalt in their vitamin B_{12}. Their publication of this finding[5] refers to the presence of phosphorus. Our own analytical figures have already indicated that the molecule contains three atoms of phosphorus.

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July 1.

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Interrelations of the Serum Protein in the Thymol Turbidity Test

THE mechanism of the thymol flocculation test developed by MacLagan in 1944 [1] has in the past four years been the subject of study by several investigators[2–5]. In the course of a detailed study of the circulating proteins of a patient suffering from advanced liver disease, whose plasma was known to give a strongly positive thymol reaction (18 units), opportunity was taken to examine the observation that normal human albumin would inhibit the thymol reaction[3].

The fraction used for the investigation consisted of the slower moving components, separated from the descending limb, by the discontinuous electrophoretic technique of Tiselius. Fig. 1 shows the distribution of the components in this fraction. It will be seen that there were two major peaks having mobilities compatible with β- and γ-globulins respectively, and one intermediate peak the mobility of which corresponded to fibrinogen. This fraction was dialysed against 0·15 molar sodium chloride at *p*H 7·0, and after dialysis gave a well-marked thymol reaction using the technique originally laid down by MacLagan[1].

To the material so obtained varying concentrations were added of (*a*) crystalline normal human serum albumin in 0·15 molar sodium chloride, and (*b*) normal human serum 'albumin' obtained by precipitation of the globulins of normal serum with 26 per cent sodium sulphate at 37° C. and subsequent dialysis against 0·15 molar sodium chloride. Electrophoretic analysis of (*b*) showed that the fraction contained perceptible amounts of α_1-globulin (see Fig. 2).

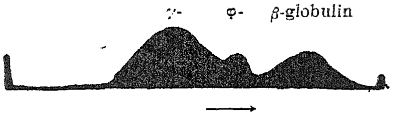

Fig. 1. PHOSPHATE BUFFER, MOLARITY 0·2 ; PROTEIN CONCENTRATION, 112 MGM. NITROGEN/100 ML.

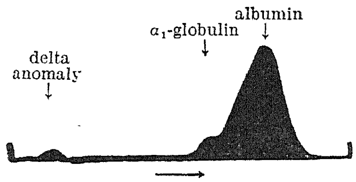

Fig. 2. PHOSPHATE BUFFER, MOLARITY 0·2 ; PROTEIN CONCENTRATION, 160 MGM. NITROGEN/100 ML.

In every instance the concentration of the globulin fraction in the final volume of saline was kept constant. The results are shown in the accompanying table.

(*a*) Crystalline human albumin

Ratio of albumin nitrogen to globulin fraction nitrogen	Thymol test
0 to 1	++
0·81 to 1	++
1·62 to 1	++
3·24 to 1	+
4·77 to 1	−
9·55 to 1	−

(*b*) 'Albumin' obtained by precipitation of globulins from normal human serum with 26 per cent Na_2SO_4 at 37° C.

Ratio of albumin nitrogen to globulin fraction nitrogen	Thymol test
0 to 1	++
0·28 to 1	−
0·56 to 1	−

The mean ratio of albumin to γ-globulin in eleven sera examined by electrophoretic analysis[6], all giving a well-marked thymol reaction, was 2·6 to 1 (σ = 0·705). This ratio of concentration is lower than that shown in the table as the minimal effective concentration to produce inhibition using normal albumin.

The inhibitory action of pure bovine albumin and of pure horse albumin was studied against the same globulin fraction, and both were found to be effective inhibitors in concentrations of the same order of magnitude as crystalline human albumin.

These results seem to suggest that the inhibitory effect of albumin as such is a function of its concentration in the system under test ; and further, that the interaction is not species specific.

The 'albumin' obtained by sodium sulphate precipitation was inhibitory in much lower concentrations than the crystalline albumins. This 'albumin' was demonstrated to be contaminated by α_1-globulin. This raises the possibility that inhibition may be a function of α_1-globulin closely associated with albumin, as well as albumin itself. An alternative rationalization of the observation is that in the process of crystallization, the specific reactive groupings on the albumin molecule have become modified so as to reduce its potential inhibitory effect when redissolved in normal saline.

I wish especially to express my thanks to Dr. Kekwick and to the Lister Institute for the facilities they placed at my disposal.

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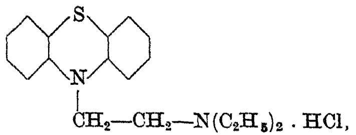
N-Diethylaminoethylphenothiazine : a Specific Inhibitor of Pseudocholinesterase

Mendel and Rudney[1] demonstrated that mammalian tissues may contain two distinct esterases, both capable of hydrolysing acetylcholine *in vitro* : a specific enzyme ('true' cholinesterase) and a non-specific enzyme ('pseudo'cholinesterase). The chemically dissimilar natures of the two enzymes were indicated by their selective behaviour towards particular choline esters[2] and by the selective toxic effects, on the pseudo esterase, of the dimethylcarbamate of (2-hydroxy : 5-phenylbenzyl)-trimethylammonium bromide[3] and of di*iso*propylfluorophosphate[4]. Both these substances exert powerful effects on pseudocholinesterase at concentrations which are relatively ineffective against true cholinesterase.

Experiments recently recorded in these laboratories indicate another organic compound which exerts a similar selective toxic action on pseudocholinesterase. The compound N-diethylaminoethylphenothiazine hydrochloride (also known as 2987 *R.P.*), of the following constitution :



was originally synthesized by Gilman and Shirley[5] and first examined pharmacologically by Bovet *et al.*[6] in connexion with its possible use in the symptomatic treatment of Parkinson's disease. It was tested for anticholinesterase activity, using the technique of Ammon[7]. The source of enzyme was either a rat brain extract, which is believed to contain only true cholinesterase[8], or blood plasma. The brain extract was prepared by grinding a whole rat brain with sand and normal saline, filtering through muslin, and diluting the filtrate with saline to a final volume of 8 ml. per gm. original tissue. Enzyme activities were measured at 37° C., using as substrates acetylcholine, acetyl-β-methylcholine (mecholyl) and benzoylcholine, in presence of various concentrations of 2987 *R.P.*, and measurements of carbon dioxide output in every case were made for a period of 1 hr. after equilibration. Controls without drug and without substrate were also set up. Typical results are shown in the table.

It will be seen that, while the activity of pseudocholinesterase, indicated by the action of plasma on benzoylcholine, is strongly inhibited by 2987 *R.P.* at concentrations of the order of $0 \cdot 075 \times 10^{-4}$ *M* and $0 \cdot 24 \times 10^{-4}$ *M*, the activity of the true cholinesterase, indicated by the action of brain extract on acetylcholine and of plasma on mecholyl, is not affected appreciably by the drug even at much greater concentrations, of the order of $5 \cdot 1 \times 10^{-4}$ *M*.

Source of enzyme	Concentration of substrate	Concentration of 2987 *R.P.*	% Inhibition of enzyme
0·5 ml. brain extract	0·007 *M* acetylcholine	$5 \cdot 1 \times 10^{-4}$ *M*	0
0·5 ml. rat plasma	0·007 *M* mecholyl	$3 \cdot 0 \times 10^{-4}$ *M*	9·2
0·5 ml. rat plasma	0·006 *M* benzoylcholine	$0 \cdot 24 \times 10^{-4}$ *M*	74·0
0·3 ml. guinea pig plasma	0·006 *M* benzoylcholine	$0 \cdot 075 \times 10^{-4}$ *M*	87·3

The results are in harmony with the views expressed by Mendel *et al.*[1,2] regarding the chemically distinct natures of the two types of cholinesterase.

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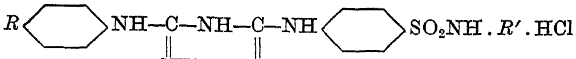
Metachloridine-substituted Aryl Biguanides as Possible Antimalarial Compounds

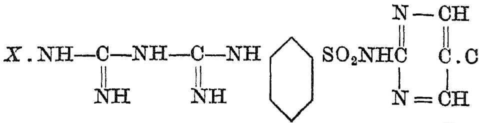
METANILAMIDES are reported to have no antibacterial action[1], and from the parallel nature of the antimalarial and antibacterial properties of sulphanilamides, discouraged research in the field of metanilamides as possible antimalarials. Recently, English *et al.*[2] discovered enhanced antimalarial activity in 2-sulphanilamido-5-chloropyrimidine, and their work resulted in the discovery of metachloridine[3] (*SN* 11437) (2-metanilamido-5-chloropyrimidine), which has been found to be effective both in avian[3] and human malarias[4,5,6]. Metachloridine is 5-chloropyrimidine-substituted metanilamide, the action of which is not affected by the presence of *p*-aminobenzoic acid, and is supposed[3] to have a double mode of action due to the presence of 5-chloropyrimidine and metanilamide parts in the molecule.

Previously, sulpha-biguanides of type (*A*), some of which have shown encouraging antimalarial activity against avian malaria (*P. gallinaceum*), have been reported by us[7,8]. The following compounds of type (*B*) have also been prepared (see table), where metachloridine forms the N^5-substituent of N^1-arylbiguanides.



Type (*A*)

R = H, Cl, Br, NO_2, CH_3, etc.
R′ = H, 2-thiazolyl, 2-pyrimidyl, 4 : 6-dimethyl-2-pyrimidyl, 6-methyl-2-pyrimidyl.



Type (*B*)

X = substituted aryls.

N^1-Aryl-N^5-metachloridino-biguanides

X	M.p. of the hydrochloride (° C.)	M.p. of the free base (° C.)
1. Phenyl	232	234
2. *p*-Chlorophenyl	235	239
3. 2 : 4-Dichlorophenyl	256	234
4. *p*-Bromophenyl	227	243
5. *p*-Iodophenyl	208 (decomp.)	239
6. *p*-Methylphenyl	237	233
7. 3 : 4-Dimethylphenyl	246	232–234
8. *p*-Methoxyphenyl	202	236
9. *p*-Nitrophenyl	252	237

The hydrochlorides of these compounds have been prepared by the reaction of the appropriate aryl-cyanoguanidines with metachloridine hydrochloride in solvents like aqueous dioxan or 90 per cent ethanol. The free bases and the hydrochlorides are white crystalline powders.

During the preparation of the copper chelates of the substituted biguanides of types (*A*) and (*B*) by Andreasch's[9] method, the simple sulphanilamide-substituted aryl-biguanides (type *A*, *R'* = H) yielded the chelates readily, while those with heterocyclic sulphanilamides and metachloridine as substituents showed very feeble tendency towards chelation, perhaps due to the enhanced electro-negative nature of the sulphonamido group.

m-(5-Chloro-2-pyrimidyl)-sulphonamidophenyl-azo-cyanoguanidine did not lend itself to denitrogenation to give the corresponding cyanoguanidine compound. Details will be published elsewhere.

We thank the Indian Research Fund Association for the award of a fellowship to one of us (H. L. Bami).

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Bangalore. Feb. 27.

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Presence of a Parasitic Agent in Various Intracranial Tumours of Man

In a preliminary communication[1], one of us (C. J.) reported how, by following up indications that gliomas of the domestic fowl arise as foci of chronic inflammation and appear to be a response to the presence of some irritant influence, he was led to the demonstration of a parasitic agent associated with the lesions of glioma and encephalitis in this species. Bodies (*A*, *B*, *C* and *D*) were described and illustrated which were claimed to be phases of a pleomorphic parasite, while others (*E*) were strongly suspected, and still others considered possibly to represent further phases. In glioma and in chronic disseminated encephalitis, it was the *C* and *D* bodies that were especially demonstrated, while the *A* and *B* bodies tended to be more characteristic of purulent encephalitis.

These findings made it imperative to examine human gliomas for the possibility of the presence of some comparable agent; all tumours, whether gliomas or not, recently removed in the Neurosurgical Department of the Johannesburg Hospital have therefore been so examined.

The results are shown in the accompanying table.

PARASITIC BODIES IN TUMOURS FROM THE NEUROSURGICAL DEPARTMENT, JOHANNESBURG

Case No.	Diagnosis	Parasitic phases: *C* Bodies	*D* Bodies	Strongly suspected phases: *E* Bodies	Possible phases: *F*, *G*. *H*, etc.
1	Medulloblastoma	+	++*	+	
2	Medulloblastoma	+	+*	+	+
3	Medulloblastoma	+	+*	+	+
4	Spongioblastoma multiforme	+*		+	+
5	Spongioblastoma multiforme	+*	+	+	+
6	Spongioblastoma multiforme	+*	+	+	+
7	Spongioblastoma multiforme	+*		+	+
8	Meningioma Type III–IV	+*		+	
9	Meningioma Type III	+*	+	+	+
10	Meningioma Type III	+*		+	
11	Meningioma Type III	+*		+	+
12	Meningioma Type III	+*		?	
13	Meningioma, Spinal, Mixed	+*	+	?	+
14	Meningioma, Xanthomatous	+*	+	+	+
15	Pituitary adeno-carcinoma	+++*	+	+	+
16	Chromophobe adenoma	+*	+	+	+

+ Present. ++ Fairly frequent. +++ Very frequent. * More frequent or prominent than other phases. ? So rare that some doubt was felt.

In all of sixteen cases of glioma, meningioma or pituitary neoplasms, we have been able to demonstrate bodies indistinguishable from the *C* and *D* phases of the fowl parasite, while in most cases the suspicious *E* bodies and the other possible phases have also been seen.

All the varieties of *C* bodies (*C*, oval; C^1, double oval; C^2, piriform; C^3, bipolar; and C^4, ring- or horseshoe-shaped) encountered in the fowl have been identified in man.

It will appear from the table that *D* bodies tend to be more characteristic of medulloblastoma on one hand, and *C* bodies of meningiomas and pituitary tumours on the other. In the meningiomas no correlation could be found between the type of tumour and the variety of the *C* bodies which was predominant. But in the two pituitary neoplasms (one a β-cell adenocarcinoma, the other a chromophobe adenoma) the C^2 variety was predominant, and in these two cases there was a striking contrast in the frequency of the *C* bodies between the malignant and the benign tumour.

Properly differentiated Giemsa-stained paraffin sections of formol-fixed material and air-dried Giemsa-stained smears are both suitable for the demonstration of *C* bodies; but the *D* bodies are best demonstrated only in smears.

The bodies have been readily demonstrable only in a few cases, in other cases they were found after a short search; but in the majority of specimens, considerable and patient searching was necessary.

A full report of these findings will be published later.

We should point out that *D* bodies, considered alone, would probably not impress one as anything more definite than 'inclusion bodies'. On the other hand, *C* bodies might fairly be claimed on their own morphological merits as parasites. However, our opinion of the parasitic nature of the *C* and *D* bodies in human tumours is based chiefly on our ability in avian lesions to relate these bodies as phases of a life-cycle which includes the still more impressive schizont-like *A* body.

By analogy with avian pathology, we expect that a phase corresponding to the *A* body will prove to be demonstrable in man; but not necessarily in tumours, since in the fowl this body is more characteristic of the non-neoplastic lesions. Pending demonstration of the 'missing' phases in man, no opinion will be expressed regarding the identity of the human with the avian parasite.

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[1] Jackson, C., *Nature* [161, 441 (1948)].

The Stock of Whales

IN an article on the "Effect of Present-day Whaling on the Stock of Whales"[1], Dr. Hamilton points out that in spite of a 'rest' during the War, the Antarctic catch of blue whales in 1945–46 showed a scarcity of the largest animals, a reduced proportion of this species (30·7 per cent) in the total catch, and a reduced percentage of mature females which were pregnant; and he infers that the stock of blue whales is showing clear signs of reduction. Among other matters he points out that the limit of 16,000 'blue whale units' allows the killing of many more than 16,000 whales. Although in agreement with much of what Dr. Hamilton says, I think it should be noted that the figures for the subsequent season of 1946–47 show that blue whales were taken in relatively larger numbers, and formed about 38·5 per cent of the catch. Although this is still not very high, and gives no grounds for complacency, it is a distinct improvement on 1945–46.

It is doubtful whether the results of a single season are sufficient to indicate the condition of the stock, and since the better catches of blue whales in 1946–47 can scarcely be attributed to a sudden recovery in the stock, it is difficult to avoid the conclusion that 1945–46 was in some way an abnormal season in which the blue whales in the population were not adequately represented in the catch. The explanation may be in exceptional oceanographical conditions; but on this we have no adequate evidence. It appears that the weather at least was less favourable in 1945–46 than in 1946–47. Full details of the catches in 1947–48, and of sizes and percentage pregnant in 1946–47, have not yet, I believe, been published. It is not very clear, however, that the percentage of mature females pregnant is a wholly reliable indication of the condition of the stock.

Before the War, signs of depletion of the blue whale stock persisted over a succession of whaling seasons. If now a comparison of several seasons indicated that this stock is still declining, its position would be serious indeed. If, on the other hand, it is found to have recovered to some extent (and there is evidence, as yet unpublished, which suggests good recruitment of young blue whales), then it is important that it should not again be subjected to excessive, and in the long run uneconomic, hunting.

The international regulation of whaling is a complex subject; but briefly it can be said that the limit of 16,000 blue whale units (in preference to a specified number of whales) was adopted as the best practicable means of putting a 'ceiling' to the total Antarctic 'pelagic' catch. It represents approximately two thirds of the average annual catch before the War, and it can be reconsidered from time to time. Since 1 unit = 1 blue, 2 fin, 2½ humpback, or 6 sei whales, the larger the number of whales taken, the smaller will be the number of blue whales among them. This may not be a perfect method of limiting the catch, but it is probably the most effective of the international regulations.

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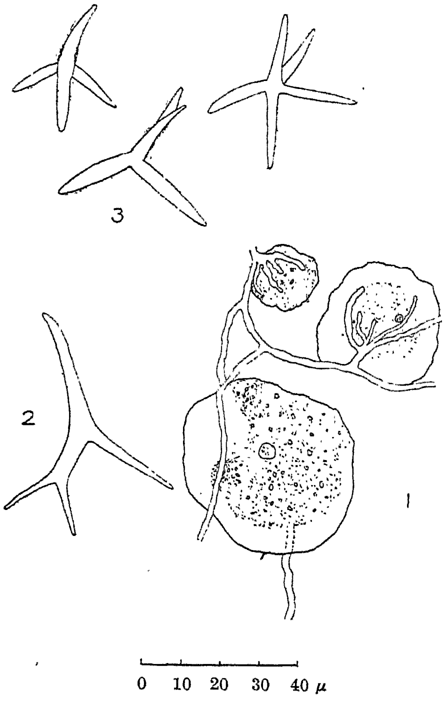
[1] *Nature*, 161, 913 (1948).

An Aquatic Predaceous Fungus, *Acaulopage dichotoma*, in Britain

IN the course of a general investigation into aquatic fungi, a predaceous Phycomycete, *Acaulopage dichotoma* Drechsler (1945) [1], has been identified for the first time in Great Britain.



The source of material was a small pond at Ken Wood, London, containing beech leaf and twig debris. In maize meal agar plates, a fungus was observed which subsisted on aquatic amœbæ. The mycelium is extremely delicate and granular, with slight branching, diameter varying between 1 and 2 μ according to age. Amœbæ, 30–45 μ in diameter, are captured and a branched haustorium 10–30 μ in length is formed which persists until complete digestion is effected, when withdrawal of protoplasm occurs (Fig. 1). When the mycelium is well established, conidia formation occurs, and exposure to light seems to stimulate their formation. A short lateral enlarges and two distal forks appear, frequently one or both forking again (Fig. 2); less regular forking is of frequent occurrence (Fig. 3). At maturity, the distal portion of each fork appears devoid of protoplasm and is termed the appendage. The conidia have forks ranging from 15 to 40 μ in length.

This fungus agrees with the general description of *Acaulopage dichotoma* Drechsler, 1945, found in water-lily leaf inoculum, and is named accordingly.

I found a greater variation in the degree of forking of conidia than is reported by Drechsler, and no trace of the clear secretion which formed yellow deposits apparently produced by the fungus as an adhesive trap for amœbæ.

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April 8.

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Osmoregulatory Capacity of Contractile Vacuoles

The view that the contractile vacuoles of Protozoa in many cases perform an osmoregulatory function has been supported by much evidence[1] which need not be repeated here. Recent observations carried out on the freshwater peritrich ciliate *Carchesium aselli* have demonstrated the remarkably close regulation of body volume which is achieved in spite of wide variation in the osmotic stress imposed by the environment.

In some experiments, in order that the internal osmotic pressure might be raised, the organisms were equilibrated with 0·05–0·5 molar solutions of ethylene glycol, which is known[2] to penetrate various cell membranes at a significant but not too rapid rate. On return of the organisms to water free from ethylene glycol, the contractile vacuole increased its rate of output immediately to from two to nine times the rate before treatment; but it subsided in the course of ten to twenty minutes to its normal level of activity, no doubt owing to the escape of the ethylene glycol from the organism. Greatly increased osmotic stress was thus met by increased vacuolar output, and the swelling which would be expected in the absence of osmoregulation was prevented or (after the higher concentrations of ethylene glycol) considerably restricted. Similarly, in experiments in which the organisms were immersed in solutions of up to 0·03 molar sucrose, which for short periods may be regarded as not penetrating in significant amount, the body volume remained unchanged (within the limits of observation) while the rate of vacuolar output was appropriately reduced.

The highly developed power of accurate osmoregulation which is therefore found in these ciliates may well be useful where the osmotic pressure of the medium is liable to fluctuate, as, for example, in estuaries. Apart from this, another important ecological aspect of this question may be suggested. It has been shown[3] for the egg of the sea urchin *Arbacia* that the rate of swelling on transfer to dilute sea water is considerably faster at higher temperatures, presumably because of increased permeability to water; and I have found this to be true also for the marine peritrich ciliate *Vorticella marina*. The Q_{10} for the permeability to water of the *Arbacia* egg has been estimated as ranging from 2·1 to 3·1 ('permeability' here including any changes which may occur either in the diffusibility of water or in the properties of the membrane); and that for *Vorticella marina* appears to be of the same order, although the precision of the results does not warrant a closer statement. But I have also found that the rate of vacuolar output of a freshwater peritrich increases with rise of temperature with a Q_{10} of 2½ to 3.

It seems reasonable to postulate that the contractile vacuole responds to small changes in the hydration of the protoplasm, whether these arise from a change in magnitude of the osmotic difference across the body surface or from a change in 'permeability' of that surface to water, so that the rate of vacuolar output is adjusted to maintain a practically constant body volume. In its natural habitat a freshwater peritrich might be exposed to seasonal extremes of 0–20° C., and in some circumstances the diurnal fluctuations might amount to several degrees. It seems that the organism would have to grade its osmoregulation to meet these changes. This may apply also to other freshwater animals, and so prove to have a general ecological importance.

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April 9.

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Course of Untreated Infections of *Litomosoides carinii* in the Cotton Rat

The efficacy of drugs in the treatment of human filariasis can be assessed by their effect on the microfilariæ in the peripheral circulation, and the effect on the adults merely inferred therefrom: in animals, however, the change induced in the adults can be assessed directly.

In recent years, *Litomosoides carinii*, the natural filarial parasite of the cotton rat, transmissible from rat to rat by the mite *Liponyssus bacoti*, has been studied in this laboratory and in others in Britain and America, with a view to its use for chemotherapeutic researches in filariasis. Much of the published work on the preliminary screening of drugs has been done with rats showing infections of unknown duration, naturally acquired in the field, and the results are interpreted as indicating that, while certain drugs kill the adult worms in the pleural cavity but do not affect the microfilariæ in the peripheral blood stream, the converse is true of other drugs, although, in some cases, only a transient reduction in the number of microfilariæ has been observed. Our observations on untreated laboratory-infected cotton rats over the past two years lead us to conclude that there is need for considerable caution in the interpretation of such observations.

In a previous communication[1], the unsuitability of the white rat as a host for this purpose was suggested, for though the course of an infection in cotton rats and white rats follows the same pattern, in the white rat the microfilariæ do not persist in the circulation for the same length of time as in the cotton rat, and the death of the parent worms and their encapsulation occurs much earlier. Though the infection in the cotton rat has the same evolution, there is less disparity between its duration and the life span of the host. Nevertheless a cotton rat infected in its youth may outlive an infection which has undergone spontaneous cure. We have been able to follow, for a year or more, the general course of the blood infection in cotton rats exposed to infection once—usually for 24 hours—by small numbers of infective mites. Microfilariæ appear in the peripheral blood on the fifty-first day after exposure, and increase during the next month or more, after which the count tends to remain more or less constant, with wide variations about the mean. In one rat, still surviving, an infection intensity, varying between 140 and 240 microfilariæ/c.mm., has been maintained for the past twelve months. On the other hand, in another rat, the general level, varying between 80 and 190 microfilariæ/c.mm., persisted for some six months ; but, during the following three or four months, the count dropped progressively until the microfilariæ finally disappeared three weeks before the animal's death, when only dead encapsulated worms were found.

In other cotton rats, infected on several occasions by mass exposure to mites, the infection has followed a similar course. Some, which showed counts of 1,500, 840, 675, 450 and 150 microfilariæ/c.mm. in the peripheral blood about the third or fourth month after infection, dropped after the seventh or eighth months to 530, 45, 30, 10 and 20 microfilariæ/c.mm. respectively, while in others, which died seven to twelve months after their last exposure, many of the adult worms were found to be dead and encapsulated.

The relationship between the death of the adult worms and the disappearance of the microfilariæ from the peripheral circulation cannot be defined in the absence of more precise knowledge of the migration-rate and the longevity of the microfilariæ. Though they are found most commonly in the peripheral circulation within one day of injection into the pleural or peritoneal cavities and the subcutaneous tissue, their persistence in the circulation in the absence of the adult varies from days to weeks and even months. Furthermore, in one such animal, a concomitant septic infection has been accompanied by a transient reappearance of the circulating microfilariæ after they had previously disappeared for a time, suggesting that redistribution may be an additional factor in their decline.

Our results cannot be taken to indicate the minimum time required before gross pathological changes are induced in the pleural sac by the adult worms, nor do they enable the duration of a particular blood infection to be estimated before the progressive and terminal fall occurs in the microfilarial count, nor can the disappearance of the microfilariæ and the death of the adult worm be correlated accurately at the moment. Nevertheless, they suggest that conclusions from treated infections should be made with due regard to the findings in untreated controls, and that results derived from wild, naturally infected cotton rats should be interpreted with caution.

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[1] *Nature*, **158**, 418 (1946).

Density of the Blackfish Petrosal

The mammalian petrosal is generally recognized by anatomists as the most compact of bones. The physical density of the various bones does not seem to have attracted much attention. The only data in the literature available to me are those of the "Smithsonian Physical Tables", where the density of bone is given as varying from 1·2 to 2·0 gm. per cubic centimetre.

Mr. J. T. Sorenson included a petrosal from a blackfish (*Globicephala melœna*) in the collection which he made in his second stay at Campbell Island in the New Zealand subantarctic group. The extraordinary density of this specimen is striking and immediately apparent when the bone is handled. Although the specimen measures only 40 mm. × 28 mm. × 18 mm. in its major dimensions, the dry weight is 17·5 gm. After boiling in water to expel air, the volume measured by immersion is 5·0 c.c.; accordingly, the physical density is 3·5, considerably exceeding the range given in the Smithsonian "Physical Tables".

In comparison, the petrosal of a dog weighed 1·34 gm. and had a volume, measured as before, of 1·0 c.c. The density of this specimen, 1·34, falls well within the limits given in the tables, and confirms the initial impression of the remarkable density of the blackfish petrosal.

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A Method for Studying the Carbohydrate Metabolism of Micro-organisms

We wish to emphasize the usefulness of the method of paper chromatography of sugar[1,2], especially when applied on a quantitative basis[3], in the study of bacterial metabolism. As an example we quote the following experiment on the utilization of sucrose by *Leuconostoc mesenteroides* (Lister Institute strain No. 3351).

Most strains of this bacterium are found to produce copious yields of a dextran from this sugar and no other[4]. The strain used had those properties.

During the production of the gum, large quantities of reducing sugars are formed, and it has been generally assumed that the glucose part of the sucrose is polymerized to dextran with simultaneous liberation of the fructose moiety[5]. Considerable interest is centred on the bacterium due to Hehre and Sugg's[6] enzymatic synthesis of the dextran.

A loopful of a 48-hr. culture of the organism (growing in Tarr and Hibbert's liquid medium[4] with the addition of 2 per cent yeast extract) was inoculated into 10 ml. of this medium, and the culture flask incubated at 28° C.

It is possible by the paper chromatography method to estimate at any desired interval during growth the

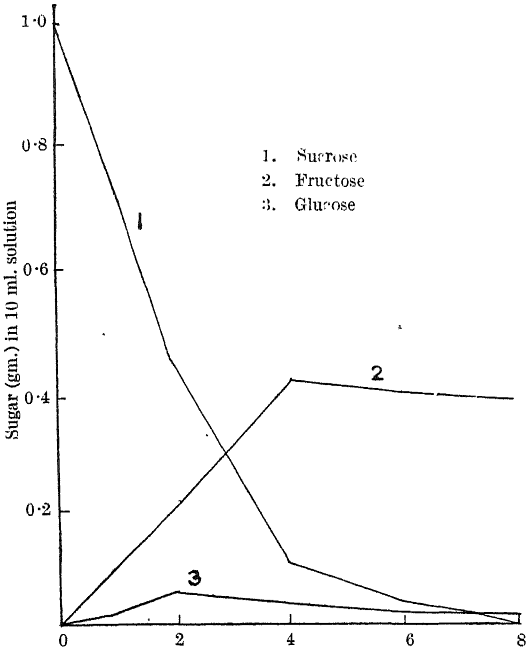

Fig. 1

glucose, fructose and sucrose present in the culture. Instead of using an internal standard[3] which might interfere with bacterial growth, an equal volume (15 µl.) measured by weighing was spotted from the culture on to a paper strip, using a flame-sterilized platinum loop for each spot. Sucrose can be detected on the paper with resorcinol[2] and estimated in the usual manner[3] after a preliminary hydrolysis with dilute oxalic acid. A check was made with known mixtures of the three sugars and nearly quantitative recovery was obtained. The results are plotted on the accompanying graph (Fig. 1) and a photograph is shown (Fig. 2) of a chromatogram obtained after two days growth. It is apparent that glucose as well as fructose is produced, although to a lesser degree. This experiment has been repeated several times with the same general result.

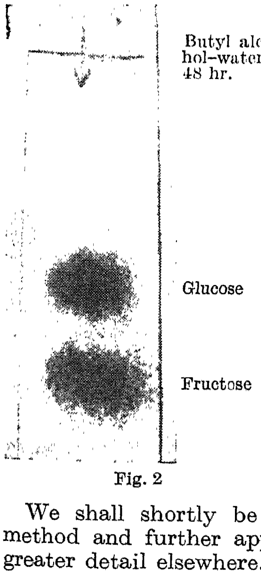

Fig. 2

We shall shortly be preparing a report of the method and further applications for publication in greater detail elsewhere.

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Voltage Effects in Titanate Polycrystals

Titanates of the perovskite type, such as the barium compound, possess ferro-electric properties at temperatures up to the Curie point, at which a λ-transition from a distorted to a cubic crystal structure takes place. Materials of this type possess high permittivities rising to a maximum in the temperature region of the transition. Beyond the Curie point, the relation between polarization and the applied field becomes linear; the ferro-electric influence, however, continues to make itself felt within a temperature region extending well above the Curie point.

In a previous communication[1], we described the variations in permittivity with time observed after the application of a unidirectional electric field to materials of this type. At temperatures below the Curie point, the permittivity was larger shortly after applying a strong D.C. field, and reverted at a decreasing rate to its initial value, within periods exceeding in some cases 30 min. Beyond the Curie point the permittivity had at first a reduced value and again reverted slowly to its original magnitude.

The permittivity of compounds of this type, measured with a small alternating field, is known to be decreased while a strong unidirectional tension is superimposed, at temperatures below as well as above the Curie point[2-4]. As no information appeared to be available on the variations of the permittivity during the application of a polarizing field, it was considered of interest to determine the curves relating the permittivity measured while a D.C. field (3,300 V./cm.) was superimposed to the time of application. At temperatures below the Curie point the permittivity was found to have an increased value on applying the field, and to fall at a decreasing rate to a steady value below that of the initial permittivity. Beyond the Curie point the permittivity decreased immediately and approached again slowly a final lower value.

It appears that the following mechanism may be responsible for the various effects observed. On the application of the field, oriented regions in the material grow at the expense of others, and owing to these changes anisotropic stresses[5] are produced on the crystallites, resulting in the displacement of the Curie point to a lower temperature. In the case of the tetragonal structure, for example, compressive forces in a direction parallel to the c-axis may predominate over those along the a-axis. At the same time, the maximum in the permittivity – temperature curve will be depressed progressively to lower values of the permittivity, owing to the increasing polarization in the material. On removal of the field, molecules added to the oriented regions revert again to their initial state, and the permittivity – temperature curve assumes its original position. Changes in the volume of the oriented regions, while rapid immediately on applying or removing the field, may continue to take place for comparatively long periods of time. The various effects observed can hence be explained by the depression of the permittivity – temperature curve, accompanied by the slight lowering of the Curie point, on the application of the field.

A similar explanation for the effects observed by us has been suggested by Szigeti[6]. According to this, the changes in the permittivity are due to a displacement of the permittivity – temperature curve by the external field, in a direction parallel to the temperature axis. It is suggested that the permittivity maximum is shifted to a lower temperature, retaining its original magnitude. This explanation, however, would be insufficient to account for the prolonged residual effects observed, if the depression in the permittivity – temperature curve is not taken into account, and without the assumption of a mechanism for the displacement of the Curie point, such as that suggested above.

It is interesting to note in this connexion that the permittivity maximum in this type of material has been reported to occur at lower temperatures in the case of strong A.C. measuring fields than at lower field strengths[7], and the explanation suggested for the residual effects is consistent also with this result.

We wish to thank the United Insulator Co., Ltd., Surbiton, for generously giving us facilities in its research laboratory during part of this investigation. We are greatly indebted also to Dr. B. Szigeti for helpful suggestions.

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Chemistry Department, Queen Mary College,
University of London. April 6.

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Chromatography of Dinitrophenyl Amino-acids and Peptides

Sanger[1] has described the use of 1: 2 : 4-fluorodinitrobenzene to identify the free amino-groups of several proteins, employing the separation of the N-dinitrophenyl amino-acids on columns of silica gel. We have had only limited success applying this method, owing to variations in different batches of the silica gel, and the difficulty of preparing evenly packed columns, which led to diffuse bands, difficult to separate. Sanger stated that with these derivatives on paper chromatograms[2] long diffuse 'tails' formed, making the method quite inferior to the silica method. We are able to report some success with the two-dimensional method, however, without apparently using any special technique which might account for the improvement. Consden *et al.*[3] have also recently described the identification of α-δ-di- dinitrophenyl -ornithine running alone on a paper chromatogram, and Keston *et al.*[4] using the *p*-I^{131}-benzenesulphonyl derivatives of amino-acids have been able to estimate them after their partial separation on a one-dimensional paper strip.

We have tried a wide range of alcohols, phenols, amines, esters, ketones and hydrocarbons, all saturated with water, but with most of these 'tailing' was marked. Best results were obtained with *n*-butanol, phenol, collidine and *n*-butanol-acetic acid mixture, each saturated with water. The solution is applied in the usual manner to No. 1 or No. 4 Whatman paper and neutralized with ammonia vapour before the run. No solvent has so far been found which will satisfactorily resolve the group of dinitrophenyl amino-acids, containing large non-polar side-chains; for example, N-dinitrophenyl-leucine, N-dinitrophenyl-phenylalanine, αε-di-(dinitrophenyl)-lysine. etc., as the addition of the large dinitrophenyl-group still further diminishes the differences between these amino-acids. However, provided that only a few of this group are present, identification by running with the added authentic derivative is possible. 5 μgm. of a dinitrophenyl acid will give a good spot on a one-dimensional strip, but 20 μgm. may be required on a two-dimensional sheet, as the yellow colour becomes difficult to see after two traverses. Ultra-violet examination[5] shows the spots as pale yellow when weak, and as obscuring dark patches in larger quantities. There is no actual fluorescence.

Some months ago, Sanger (private communication) reported that he had separated some dinitrophenyl peptides on silica columns in a similar manner to his dinitrophenyl amino-acid separations. We find that if the hydrolysis of the dinitrophenyl peptide or protein is incomplete, extra yellow spots appear, which do not correspond to the position of the dinitrophenyl amino-acids. Further hydrolysis of such materials after elution has shown them to have been dinitrophenyl peptides, of size up to heptapeptides. This good spot formation with heavy materials extends to those of very large molecular weight. For example, the dinitrophenyl derivative of the 'protein' part of insulin of molecular weight 5,000 left after chymotryptic digestion[6] (before addition of dinitrophenyl groups) runs in phenol-water as a good spot with R_F 0·56. This material and also the mixture of relatively small peptides (average, pentapeptide) from the insulin digest, before treatment with fluorodinitrobenzene, either gave no bands on paper chromatograms in the case of the heavy insulin 'core', or a diffuse overlapping mixture of bands in the case of the peptide mixture.

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March 22.

[1] Sanger, F., *Biochem. J.*, **39**, 507 (1945).

[2] Consden, R., Gordon, A. H., and Martin, A. J. P., *Biochem. J.*, **38**, 224 (1944).

[3] Consden, R., Gordon, A. H., Martin, A. J. P., and Synge, R. L. M., *Biochem. J.*, **41**, 596 (1947).

[4] Keston, A. S., Udenfriend, S., and Levy, M., *J. Amer. Chem. Soc.*, **69**, 3151 (1947).

[5] Phillips, D. M. P., *Nature*, **161**, 53 (1948).

[6] Butler, J. A. V., Dodds, E. C., Phillips, D. M. P., and Stephen. J. M. L., *Biochem. J.*, **42**, 116 (1948).

Influence of Hydrogen Ions and Neutral Salts upon the Hydration of Interstitial Connective Tissue

When a piece of interstitial connective tissue covering the thigh muscles of a rat was placed in water adjusted to *p*H 4·5, within a few hours it became opaque, white and shrunken. On the other hand, a piece treated at *p*H 11·0 became translucent, grey and swollen. These changes were mutually reversible and could be repeated several times. Observations with the dark-ground microscope showed that this swelling was not due to any change in the collagen fibrils but to a widening of the spaces between them; shrinkage was accompanied by an obliteration of such spaces and by a condensation and crimping of the collagen bundles.

Clearly, an explanation of these changes must involve a consideration of the nature of the substance which lies between the collagen fibrils. Flemming[2] described a substance in this situation which, on account of its property of contraction in weak acids, he referred to as the cementing substance. He considered the substance to be a mucin. Recently[1], I have shown that its chief characteristics are those of a protein. Following what has been said above, it should be added that this protein reacts strongly with water.

According to modern theory[3,4], the degree of hydration of a protein at different concentrations of hydrogen ions will depend upon the ionization of the NH_3^+ and COO^- radicals of the side-chains. Near the iso-electric point, a maximal number of the side-chains will be oppositely charged. The attraction of opposite charges will bring the side-chains together and result in a more compact structure with exclusion of water. On the alkaline side of the iso-electric point there will be suppression of charge on the cationic centres of the protein. A large proportion of side-chains will therefore come to possess the same negative charge and their mutual repulsion will open up the structure and lead to swelling. Theoretically, therefore, the properties of connective tissue described above are those of a protein having an iso-electric point in the region of *p*H 4·5.

Schade and Menschel[5] have shown that neutral salts may cause swelling of connective tissue. I have found that this effect is morphologically identical with that which occurs in conditions of reduced hydrogen ion concentration, and also that the reaction involved has the following features: (1) At neutrality the smallest concentrations of various salts necessary to cause swelling lie between $M/5$ and $M/20$. (2) While swelling, the tissue withdraws salt ions from the surrounding solution. (3) The capacity of a salt to cause swelling is greater with reduction of hydrogen ion concentration from the iso-electric point. (4) Although, in general, the actions of salts and hydrogen ions on the hydration of connective tissue are opposite and reversible, salts have no capacity to 'unlock' tissue which has become shrunken by prolonged treatment at a *p*H value near the iso-electric point.

It is clear that the hydration of connective tissue by the action of neutral salts is accompanied by some sort of union of salt with the protein. Probably the salt ions combine in some manner with protein side-chains. To do so, such side-chains must be available and not involved in electrovalent links with oppositely charged side-chains. Perhaps this is why salt has only a feeble 'unlocking' effect on tissue constricted by treatment near the iso-electric point of the inter-fibrillary protein, and also why, with decrease in hydrogen ion concentration away from this iso-electric point, the hydrating effect of the salt is so much greater.

It is apparent that salts exert a hydrating influence on connective tissue in physiological concentrations. This fact alone must be a matter of considerable importance not only to biological science but also to clinical medicine.

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March 21.

[1] Day, T. D., *Nature*, **159**, 100 (1947).

[2] Flemming, W., *Arch. micr. Anat.*, **12**, 391 (1876).

[3] Höber, R., "Physical Chemistry of Cells and Tissues", 296 (Churchill, London, 1945).

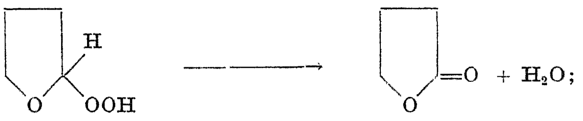
[4] Lloyd, D. J., and Phillips, H., *Trans. Farad. Soc.*, **29**, 132 (1933).

[5] Schade, H., and Menschel, H., *Kolloid-Zeitschr.*, **31**, 171 (1922).

Tetrahydrofuran Hydroperoxide

A STUDY has recently been made in these laboratories of the liquid-phase oxidation of ethers. The products of oxidation may be satisfactorily accounted for by the formation of an intermediate hydroperoxide and its subsequent decomposition. As with the hydroperoxides of hydrocarbons, those of ethers are apparently often too unstable for isolation; but in the case of tetrahydrofuran the hydroperoxide has been isolated in the pure state.

The hydroperoxide obtained by the removal of unchanged tetrahydrofuran at low pressure from a sample which had undergone oxidation by prolonged exposure to air during storage was a liquid ($n_D^{20°}$ 1·6933) at room temperature. The product gave on analysis C 46·0, H 7·9 per cent (required, C 46·1, H 7·7 per cent) and liberated the theoretical quantity of iodine from acidified potassium iodide. The hydroperoxide was completely miscible with water and soluble in the common organic solvents (acetone, methanol, acetic acid), and strongly catalysed the polymerization of styrene and methyl methacrylate. The onset of thermal decomposition occurred in the range 70–80° C., and rapid heating to 100° C. did not cause detonation, though the decomposition became more violent at still higher temperatures. The normal reagents for the destruction of peroxides (ferrous sulphate, sodium hydroxide, etc.) were equally efficacious in the case of tetrahydrofuran hydroperoxide, the chief product of both the thermal and catalysed decompositions being γ-butyrolactone. The formation of γ-butyrolactone may be accounted for by loss of water:



though the fact that tetrahydrofuran hydroperoxide is a polymerization catalyst indicates that some homolytic decomposition also occurs, probably by fission of the O—O bond.

A complete account of this work will be published elsewhere.

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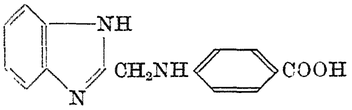
Benziminazole Analogues of Pteroic and Pteroylglutamic Acids

In the course of experiments on the relationship of structure to biological activity in the folic acid series of growth factors, we have examined the benziminazole analogues of pteroic acid and of pteroylglutamic acid[1].

The compound (I), m.p. 281° (decomp.), in which the 2-amino-4-hydroxypteridyl residue (numbering according to the "Ring Index", Reinhold, New York, 1940) of pteroic acid is replaced by a benziminazole ring, was prepared from 2-chloromethylbenziminazole[2] and *p*-aminobenzoic acid in boiling alcohol, or *via* its ethyl ester, from ethyl *p*-aminobenzoate (found: C, 66·8; H, 4·7; $C_{15}H_{13}O_2N_3$ requires C, 67·4; H, 4·7 per cent). The benziminazole analogue of pteroylglutamic acid was obtained as a



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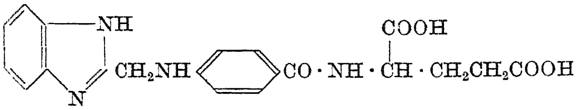

II

diethyl ester (m.p. 125°) by the condensation under similar conditions of 2-chloromethylbenziminazole and ethyl *p*-aminobenzoyl-*L*-glutamate (III). Hydrolysis with cold aqueous alcoholic sodium hydroxide gave the required acid (II), isolated as a hydrochloride, m.p. 201° (found after drying at 100° in a vacuum: C, 55·6; H, 4·7; N, 12·6; Cl, 8·1; $C_{20}H_{20}O_5N_4$,HCl requires C, 55·5; H, 4·9; N, 12·9; Cl, 8·2 per cent).

The *p*-aminobenzoylglutamic ester (III) is conveniently prepared by refluxing a solution of *p*-nitrobenzoyl chloride in benzene with ethyl glutamate hydrochloride, followed by catalytic reduction of the product. The *p*-aminobenzoylglutamic acid obtained by hydrolysis of (III) has m.p. 167° and in *N* sodium hydroxide solution, $[\alpha]_D^{22^\circ} = + 29\cdot2^\circ$, comparable with the recorded value for the *D*-isomer of $[\alpha]_D = - 27\cdot4^\circ$ [3]. Published accounts[4] of the preparation of *p*-nitrobenzoylglutamic acid from glutamic acid recommend the use of excess *p*-nitrobenzoyl chloride. We have found that by the simultaneous addition of the acid chloride (1 mol.) dissolved in dioxane and of an equivalent of 2*N* sodium hydroxide to a solution of glutamic acid (1 mol.) in its equivalent of *N* alkali, *p*-nitrobenzoylglutamic acid of m.p. 114–116° and $[\alpha]_D^{19^\circ} = + 16\cdot9^\circ$ can be obtained in 70–80 per cent yield[5]. A full description of these experiments will be published in due course.

It has recently been found by Edwards, Starling, Mattocks and Skipper[6] that the benziminazole (II) replaces 'folic acid' as a growth factor for *Strep. fœcalis* R. (though at much higher concentrations), and also stimulates growth in presence of sub-optimal concentrations of folic acid. Similar experiments by us have, however, given different results. For *Strep. fœcalis* R., grown in the improved medium of Rabinowicz and Snell[7], modified by the omission of glycine and asparagine and by the inclusion of pyridoxin (100 µgm./l.), adenine and guanine (each 5 mgm./l.), the benziminazole (II) (10^{-9} to 10^{-3} *M*) did not replace pteroylglutamic acid. Growth was measured turbidimetrically after 20 hr. incubation at 37°. Nor was the organism stimulated in the presence of sub-optimal amounts of pteroylglutamic acid, but, on the contrary, under the latter conditions, growth was inhibited, although this inhibition was not observed when pteroylglutamic acid was added in amounts which afforded optimal growth in the absence of (II). Tests made with *Lactobacillus casei*, using the medium of Roberts and Snell[8] and estimating growth turbidimetrically after incubation for 22 hr. at 37° in an atmosphere of 95 per cent hydrogen, 5 per cent carbon dioxide, gave essentially the same results.

INHIBITION OF GROWTH OF *Strep. fœcalis* R. BY THE BENZIMINAZOLE (II) IN PRESENCE OF PTEROYLGLUTAMIC ACID

Pteroylglutamic acid (molar conc.)	Benziminazole (II) (molar conc.)	Absorptiometer reading*
0	10^{-3} to 10^{-9}	0·00
10^{-9}	0	0·44
,,	10^{-7}	0·43
,,	10^{-5}	0·37
,,	10^{-3}	0·28
2×10^{-9}	0	1·05
,,	10^{-4}	0·82
,,	10^{-3}	0·52
$1\cdot6 \times 10^{-8}$	0	1·57
,,	5×10^{-4}	1·50

* Averages of quadruplicate tubes after incubation for 20 hr.

It is possible that the discrepancy between our results and those of Edwards *et al.* may be due to variations in the respective media. It is noteworthy that the medium used by the American experimenters gave measurable growth for *Strep. fœcalis* R. in the absence of added folic acid. Unlike that described by Edwards *et al.*, which was acetate buffered and contained adenine, guanine, xanthine and uracil, the medium we have employed was buffered with citrate and contained neither xanthine nor uracil. In the light of recent work in this field[9], differences in the pyrimidine-purine content of the two media may well be significant.

The simple benziminazole (I) also, when tested with *Strep. fœcalis* R., was found to be inhibitory, though less so than compound (II), and was inactive as a substitute for pteroylglutamic acid.

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April 3.

Angier *et al.*, *Science*, **103**, 667 (1946); *J. Amer. Chem. Soc.*, **70**, 14 (1948).

[2] Bloom and Day, *J. Org. Chem.*, **4**, 14 (1939).

[3] Winter, *J. Amer. Chem. Soc.*, **62**, 3266 (1940).

[4] Auhagen, *Z. physiol. Chem.*, **277**, 197 (1943). Van der Scheer and Landsteiner, *J. Immunol.*, **29**, 371 (1935).

[5] Cf. Steiger, *J. Org. Chem.*, **9**, 396 (1944).

[6] *Science*, **107**, 119 (1948).

[7] *J. Biol. Chem.*, **169**, 631 (1947).

[8] *J. Biol. Chem.*, **163**, 499 (1946).

[9] Rogers and Shrive, *J. Biol. Chem.*, **172**, 751 (1948).

The Sommelet Reaction

IN a communication under this heading in *Nature* of May 8, p. 723, Messrs. Anyal and Rassach refer to a paper by Graymore and Davies[1], in which it was shown that a mixture of benzylamine and formaldehyde gives benzaldehyde in good yield on heating in solution with hexamine. They say that, contrary to Graymore and Davies' findings, benzaldehyde can be obtained from benzylamine hydrochloride in the absence of hexamine. In a later paper by Graymore[2], it is shown that hexamine may be dispensed with, and benzaldehyde produced by heating methylene benzylamine (or, for that matter, a mixture of benzylamine and formaldehyde) with two-thirds of the quantity of hydrochloric acid, as required by the equation:

$$(C_6H_5CH_2.N{:}CH_2)_2 + 2HCl = 2C_6H_5.CH_2.N{:}CH_2,HCl.$$

It was hoped to obtain benzylidene methylamine from methylene benzylamine, but the attempt failed, the experiment resulting in the formation of benzaldehyde, methyl benzylamine and dimethyl benzylamine. Work is, however, still proceeding in this field.

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June 29.

[1] Graymore, J., and Davies, D. R., *J. Chem. Soc.*, 293 (1945).

[2] Graymore, J., *J. Chem. Soc.*, 1116 (1947).

BIOGENESIS OF THE STRYCHNOS ALKALOIDS

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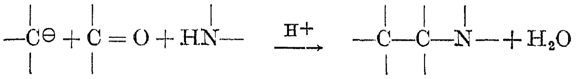
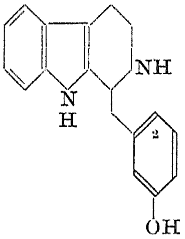
ROBINSON[1] and Schöpf[2] have developed with conspicuous success the concept that a fundamental reaction of biogenesis involves the condensation between an amino (or imino) group, a carbonyl group and an anionoid centre :



$$-\overset{|}{\underset{|}{C}}{}^{\ominus}+\overset{|}{\underset{|}{C}}=O+H\overset{|}{N}- \xrightarrow{H^+} -\overset{|}{\underset{|}{C}}-\overset{|}{\underset{|}{C}}-\overset{|}{N}-+H_2O$$

Type *A* reaction

In a particular application of this idea, Hahn[3] has suggested that in the biogenesis of the alkaloids of the yohimbé group, tryptamine, from tryptophane, and 3-hydroxyphenylacetaldehyde (or an equivalent), from 3-hydroxyphenylalanine, condense by reaction (*A*) to give (I), and that from (I), by another reaction of type *A*, involving in this case formaldehyde (*or* an equivalent), N^b and the anionoid 2-position of the aromatic nucleus, (II) is produced. The latter contains the complete ring skeleton of yohimbine (III) ; the further changes necessary for the elaboration of (II) into (III) would not be unusual, and the various possibilities need not be discussed here.



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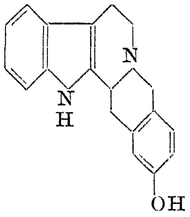
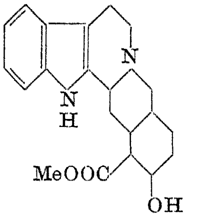
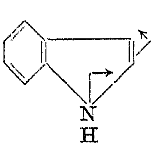


II

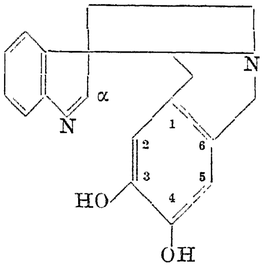


III

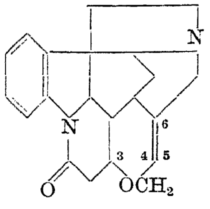


IV

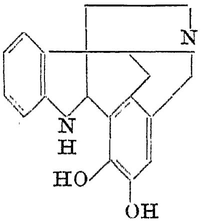
It is well known that the indole ring possesses anionoid reactivity at the β- as well as at the α-position, in consequence of the availability of electrons through the process shown in (IV, arrows). Consequently it is of interest to inquire as to the course of the reactions outlined above if condensation were to occur at the β- rather than the α-position. It is clear that, in this case, if 3,4-dihydroxyphenylalanine be considered the precursor, the product corresponding to (II) will be (V). It will be seen at once that the expression (V) contains striking similarities to many of the features of the strychnine molecule (VI). Moreover, the further elaboration of (V) in the direction of (VI) would involve for the most part relatively simple changes. Thus, since —CH = N— is equivalent to —CHO NH_2—, the opportunity is present in (V) for a further reaction of type *A*, leading to the establishment of a new bond, as required, between the α-position of the indolenine nucleus and the anionoid 2-position of the carbocyclic ring. Steric considerations might bar this reaction in this simplest form, since the product, (VII), contains a double bond in an unusual position. On the other hand, it has been shown recently[4] that the *meta* positions of an aromatic nucleus can be bridged by a chain of five atoms, and, in any event, the reaction could lead to an unstrained tautomer of (VII), for example, (VIII) ; or alternatively, the condensation could occur at a later stage, since in the subsequent stages C_3 is likely still to bear the oxygenated substituent necessary for the conference of anionoid properties on C_2. Further, the (presumably, but not necessarily, oxidative) breaking of the carbocyclic ring (of V, VII *or* VIII) between the hydroxyl-bearing atoms C_3 and C_4 gives at once the system necessary for the formation of the seven-membered ether ring of (VI), namely,



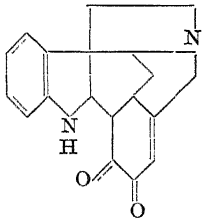
V



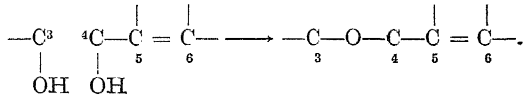
VI



VII



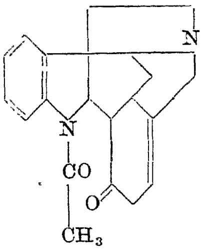
VIII



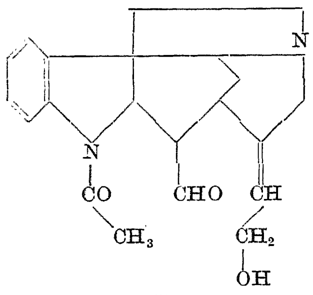
$$-\underset{\substack{|\\ OH}}{C^3}\quad {}^4\underset{\substack{|\\ OH}}{C}-\overset{|}{\underset{5}{C}}=\overset{|}{\underset{6}{C}}- \longrightarrow -\underset{3}{C}-O-\underset{4}{C}-\overset{|}{\underset{5}{C}}=\overset{|}{\underset{6}{C}}-.$$

Apart from changes in the oxidation state of the molecule, the only further modification necessary for the construction of (VI) involves the interpolation of the two carbon atoms necessary for the completion of the lactam ring of (VI). It must be admitted that, at present, this part of the scheme appears to possess unusual features, and a detailed discussion of the various possibilities is scarcely justifiable. On the other hand, it may be noted that the acetylation of N^a (*cf.* aspidospermine, which may well contain a similarly situated N-acetyl group, and colchicine, as an example of the occurrence of acetylation in the biosynthesis of alkaloids), followed by condensation between an oxygenated cationoid function at C_3 and the reactive methyl group of $-\overset{|}{N}COCH_3$, would lead to a six-membered lactam ring.

Clearly the scheme as a whole is a flexible one, and many specific variants might be considered. If, for example, the intermediate (IX) were reached, through the initial participation of 3-hydroxyphenylalanine, as assumed by Hahn in the case of the yohimbé alkaloids, or through reductive processes from (VII)



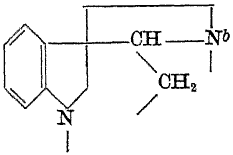
IX



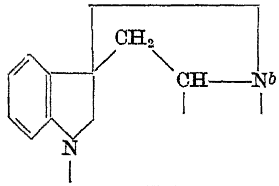
X

or (VIII), the opportunity exists for a variant of the well-known photolytic cleavage[5] of cyclic ketones, leading to (X); the conversion of (X) to strychnine itself (VI) would involve simply a single further reaction of type *A*, in which $-\mathrm{OH}$ replaces $-\mathrm{NH}_2$. Further, it should be pointed out that the order of the stages indicated should not be considered fixed. Thus, the aldehyde component might enter the scheme after some modification of the carbocyclic ring has already occurred. For example, the condensation of tryptamine, a formaldehyde equivalent, and a *dihydro-derivative* of 3-hydroxyphenylacetaldehyde could lead directly, by the reactions indicated above, to (IX) (acetyl group missing). Finally, the possibility may be kept in mind that preliminary oxidation of the indole nucleus at the α-position might serve to force the initial condensation exclusively into the β-position.

On the whole, the possibility of building up so complicated a structure as (VI) by a series of simple reactions from plausible starting materials is so striking that it is difficult to believe that the scheme lacks significance. It is worthy of note that biogenetic considerations of this kind several years ago led us to consider that the environment of N^b in the strychnine molecule was that shown in the part structure (XI) rather than that (*cf.* XII) accepted at that time[6]. We felt, however, that in view of the relatively undeveloped state of knowledge in the field of biogenesis, the proposal of these considerations as a possible biogenetic scheme should follow rather than precede the definite chemical proof of the primary consequences of its acceptance. Since this proof has recently been brought to a successful conclusion in our Laboratory[7], our confidence in the scheme is sufficient to bring us to suggest that other alkaloids will be found which owe their genesis to less, or more, complicated variants of the same process, and investigations in this direction are already in progress.



XI



XII

Sir Robert Robinson writes:

When in New York in early 1947, I learned from Dr. Woodward that he had developed a scheme of biogenetic relations between strychnine and yohimbine. The details now available follow well-trodden paths in most respects; for example, the β-condensation would be included in any such hypothesis. The suggested fission of a benzene nucleus is, however, highly original. This daring speculation must be judged at this stage by 'the degree of coincidence' which called for it.

In the thirty years that have elapsed since my first paper on these topics, considerations of this kind have been constantly in mind and conclusions have been reviewed and modified when necessary. I therefore feel justified in stating that in my opinion Woodward's theory is probably correct in essentials. May I also venture to deprecate in advance a flood of further speculation on similar lines, unless it is supported by a comparable 'degree of coincidence'. It is obvious that by chopping up benzene rings and recombining the fragments, almost any kind of structure can be obtained.

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[1] Robinson, *J. Chem. Soc.*, **111**, 876 (1917).

[2] Schöpf, *Z. angew. Chem.*, **50**, 787, 797 (1937).

[3] Hahn and Ludewig, *Ber.*, **67**, 2031 (1934). Hahn and Werner, *Ann.*, **520**, 123 (1935). Hahn and Hansel, *Ber.*, **71**, 2192 (1938).

[4] Prelog and Wiesner, *Helv. Chim. Acta*, **30**, 1465 (1947).

[5] Ciamician and Silber, *Ber.*, **41**, 1071, 1928 (1908); **43**, 3140 (1910); **46**, 3077 (1913).

[6] Holmes and Robinson, *J. Chem. Soc.*, 603 (1939).

[7] Woodward, Brehm and Nelson, *J. Amer. Chem. Soc.*, **69**, 2250 (1947).

INTERNATIONAL CONGRESS ON ANALYTICAL CHEMISTRY

An International Congress on Analytical Chemistry, organised under the auspices of the Netherlands Chemical Society, was held at Utrecht during June 1–3. The president of the Congress was Prof. C. J. van Nieuwenburg, of Delft Technical University, and the general secretary, Dr. H. A. J. Pieters, of the Central Laboratory of the Netherlands State Mines. The Congress was divided into five sections dealing with: (I) general methods and standardization, (II) electrical methods, (III) emission spectrography, (IV) optical measurements and physical methods of separation, (V) microbiological methods and detection of traces. The proceedings consisted of thirteen formal lectures and the reading of forty-five original papers. Full-length pre-prints of the papers had been distributed before the Congress, so that after a short summary by each author most of the time was available for discussion. The proceedings were conducted in English, with French as the second language. The lectures and papers contributed to Sections I, II, IV, and V will be published in a special number of *Analytica Chimica Acta*, and those to Section III in *Spectrochimica Acta*.

The Congress was attended by about forty British analysts and by representatives from Belgium, Czechoslovakia, Denmark, France, Switzerland, and Sweden. Papers were also contributed from the United States. Holland was represented by more than two hundred and fifty chemists and physicists.

Visitors to the Congress could not be unimpressed by the great changes that analytical chemistry has undergone in recent years. Because of the demand for greater speed and accuracy and because of the need for handling much smaller quantities of material, the old classical methods based on gravimetric and volumetric procedures are being replaced by physicochemical techniques. As a result of this development, the status of analytical chemistry is being raised to a much higher level, and analytical chemistry is becoming a science for the specialist.

Modern analysis, with its interests in optical, electrical and microbiological techniques, makes very great demands on the training of its practitioners, and it was emphasized by speakers from several countries that the training of analytical chemists lags a long way behind the requirements of modern industry.

Prof. van Nieuwenburg, in his opening address to the Congress, remarked that most of the developments in modern analytical chemistry had originated in the requirements of industry, and pointed out that this was borne out by the type of papers contributed to the Congress. He commented on the high cost of modern analytical equipment and said that much of it could only be purchased by the larger industrial laboratories; even these have to make a selection from the wide range of available instruments. An opportunity for the exchange of experiences gained in different laboratories with these modern techniques, such as was offered by the Congress, was most useful, and the dissemination of information in this way might lead to a saving of both time and money that might have been spent on inappropriate or useless equipment.

Most of the lectures and papers dealt with problems arising directly from the demands of industry. Dr. E. C. Wood, in his lecture on statistical aspects of chemical analysis to Section I, discussed the methods of sampling which enable the information sought by the analyst to be obtained as economically as possible. He stressed the need for proper randomization both in sampling and in performing analyses, and gave a short account of the use of 'quality control' charts in analytical work. He directed attention to the possibility of estimating the standard error from the range and described a method for extracting the maximum information from analytical investigations involving the estimation of a ratio. The advantages of the 'factorial' as opposed to the 'classical' type of experimental design was demonstrated and reference made to the value of carrying out an analysis of variance when examining the experimental data. Mr. W. J. Gooderham described and demonstrated his soap-film apparatus for the continuous analysis of coal gas.

Prof. E. Leclerc lectured to Section II on electrical methods of analysis. After reviewing the available methods and discussing their speed and accuracy, he described their applications in the Belgian metallurgical and petroleum industries. Prof. C. Duval spoke on automatic gravimetric analysis in inorganic chemistry and described some new polarographic procedures. Mr. E. Loeuille (Section III) discussed the possibilities and limitations of quantitative spectrographic analysis.

The lectures to Section IV were given by Prof. G. Duykaerts and by Dr. T. I. Williams on absorptiometric methods in chemical analysis and on chromatography respectively. Dr. Williams dealt with partition chromatography, the chromatography of inorganic substances, and the theory of chromatography. He described how the urgency of the Plutonium Project had stimulated work on the theory of chromatography. Dr. W. F. J. Cuthbertson lectured to Section V on recent developments in microbiological assay. He described the different techniques by which micro-organisms may be used for the assay of vitamins and amino-acids, and indicated possible future developments. Prof. A. G. Bertrand spoke on the determination of trace elements in plants and animals.

Dr. H. W. Thompson addressed the final session of the Congress on methods based upon infra-red and ultra-violet measurements. He reviewed the war-time achievements of infra-red analysis in the petroleum field and gave a critical survey of the available commercial instruments. Prof. P. E. Wenger summed up at the conclusion of the Congress.

A high scientific standard was maintained throughout the Congress, which was held in the pleasant rooms of the Esplanade, Utrecht's modern theatre. The Dutch organisers are to be heartily congratulated on the excellent way in which the Congress was arranged.

METABOLIC ASPECTS OF CONVALESCENCE*

THE fifteenth meeting of the Conference on Metabolic Aspects of Convalescence was once again one which devoted the greater part of its deliberations to one particular topic; on this occasion the subject was "Isotopes".

Put together in printed form, the discussions make an extremely useful review of the rapidly widening application of this comparatively new technique for the study of biological problems. Already we have been forced to revise many of our long-held beliefs regarding the nature of the metabolic processes of the body. Interpretations which provided plausible explanations of previously recorded data no longer suffice. As one member of the Conference put it, "The availability of these materials [isotopes] as tools for biological experimentation will have as profound and stimulating an effect on biological and medical science as did the discovery of the microscope". Work already completed suggests that this remark is no exaggeration.

As with all newly developed techniques, however, there are pitfalls for the unwary. In this instance, in addition to the usual initial difficulties of use and interpretation, there is the physical danger of radiation injury to the workers and assistants in the laboratories concerned. Since the hazard is an invisible one, the victim remains unaware of his injury until material damage has been done. With the present rapidity of spread in the use of radioactive materials it is inevitable that they should sometimes be handled by individuals unaware of the danger, and the part of the Conference report which deals with the diagnosis of early radiation injury and the precautions that should be taken to prevent tissue damage should be carefully studied. A statement from the National Cancer Institute is included which says, *inter alia*, "It must be emphasised that the absorption of radiation is always connected with damage, no matter how small the dose. It must also be emphasised that radiation effect may be cumulative." This places a heavy responsibility on the directors of laboratories in which work of this nature is in progress. There must be no repetition of the sufferings of the early radiologists.

In addition to the discussion of these practical issues, there are detailed considerations on the measurement of isotopes, on the synthesis of labelled compounds, and on their use in clinical investigations and in the treatment of disease.

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* Conference on Metabolic Aspects of Convalescence. Transactions of the Fifteenth Meeting, New York, 31st March, 1947. Pp. 163. (Josiah Macy, Jr. Foundation, 565 Park Avenue, New York 21.) 2.25 dollars.

In all these the reader has the advantage—inherent in the form in which these transactions are published —of not only learning what an experimenter has to say about his work, but, in addition, seeing the comments it elicited from other keenly interested participants. The question and answer, and the pooling together of small observations which, in isolation, might seem unimportant or meaningless, encourage a clarification and building up of ideas. The contrasting styles of the different contributors also make the reading of these publications much more enjoyable than the reading of some technical journals in which the papers have been so zealously 'edited' that all trace of individual style of expression has disappeared.

The remaining topics discussed at this fifteenth meeting were mostly concerned with hormone studies, and several of the papers consisted in the presentation of further data from work which had already been reported at earlier meetings. The interdependence of the multifarious metabolic activities which take place in the human body and the consequent folly of trying to interpret any one in isolation become more and more evident as each set of these transactions is put together.

M. W. Grant

MECHANICAL FOAM FOR FIGHTING PETROL FIRES

Foam for dealing with petrol fires can be generated in two ways: by chemical reaction (chemical foam), or by mechanical agitation (mechanical or air foam). Mechanical foam is largely used in Great Britain and is produced by churning up air and water with a foam-stabilizing agent, such as saponin or soap. The foam-making branch pipe is the apparatus in general use by fire services.

The use of foam appears to have been originally suggested by Laurent in 1904. He successfully demonstrated at St. Petersburg the use of chemical foam against burning naphtha. In 1912, the first foam fighting apparatus for fire-brigade use was introduced into Britain. By 1939, one or two efficient foam compounds were available; but they were both expensive and made from imported materials. With the outbreak of hostilities there came the probability of a large increase in the incidence of petrol fires and also the danger of a shortage of raw materials. Consequently, at the request of the Ministry of Home Security, Research and Experiments Department, an investigation into the whole problem of suitable foaming agents for combating fires of inflammable liquids was undertaken at the Chemical Research Laboratory of the Department of Scientific and Industrial Research. The experimental team was under the leadership of Dr. N. O. Clark, who is the author of Chemical Research Report No. 6: "A Study of Mechanically Produced Foam for Combating Petrol Fires" (London: H.M. Stationery Office. 2*s.* 6*d.* net), in which full details of the problem, the course of the researches and the results obtained are given.

Large-scale methods were developed which permitted a quantitative estimation of the value of foam as a fire-fighting agent, and also a laboratory technique was devised for the investigation of the physical properties of foam. The nature and properties of suitable foaming agents, such as chemically broken down hoof and horn meal, or glue mixed with materials similar to soapless shampoos or chemically treated blood, were elucidated. The use of chemically treated blood—a waste material from abattoirs—as a foaming agent was discovered by the research team. This new compound had the additional advantage of a much lower viscosity than other types and so could be used without modification in R.A.F. crash tenders. It produces a high-efficiency foam for combating aircraft fires, and during the War production was devoted entirely to this particular type of foam.

On the purely scientific side, quantitative evidence was obtained in favour of Plateau's classical theory of foam stability. It would appear that the expansion property depends on the interfacial tension, air/liquid, at the appropriate age of the surface, and the rate of diffusion of the active material into the surface, and is limited by the energy-level of the method of preparation. The hydrolysed proteins are, for example, slow in diffusing into the surface of their solutions. A close relation was shown to exist between the critical shearing stress of a foam prepared from a liquid with appreciable solidity in its surface to that of the corresponding liquid surface.

For the first time, a proper scientific background to the problem has been established, and the 'figure of merit' of foam on a petrol fire can be roughly estimated, but not accurately predicted, from laboratory measurements of the properties of foam, the most important being heat resistance, expansion, and petrol resistance. There is still need for relating laboratory experimental data with those of large-scale tests.

S. Weintroub

LINEN INDUSTRY RESEARCH ASSOCIATION

The report of the Council of the Linen Industry Research Association, Belfast, for the year ended September 30, 1947, states that the strengthening of the financial position of the Association, which now includes practically all the firms in the industry, has permitted the Council to proceed with the Director's plans for expansion, and the new buildings have been commenced. In addition to the large shed with a floor space of 9,800 sq. ft. for technological researches on line and tow preparing, dry spinning and weaving, which forms the main extension, the new plans include the provision of more staff amenities and facilities, extension of the testing-room and further space and equipment for research in bleaching, dyeing and finishing. Reference is made to the co-operation in research which has already flowed from the liaison service described in the last annual report. Comprehensive surveys of conditions of temperature, humidity and ventilation in wet spinning mills have brought to light many striking anomalies, and have led to suggestions by which decided improvements can often be introduced very economically into the working conditions by comparatively simple measures.

Studies in the retting of different types of straw by various methods in the large-scale retting tanks have continued, and in view of the larger differences in yield caused by variations in weather conditions during field-drying of the retted flax, attention has been focused on treatments to prevent such microbiological deterioration. Investigations are being continued to improve the efficiency of fibre extraction by turbine scutching machines. An investigation for the Ministry of Supply has shown that the strength of flax yarn depends on the fibre-breaking stress, the fineness and the length of the fibre strands in the raw. A study has also been made of the levelness of rayon staple yarn spun on flax machinery, and one commenced on the suitability of flax machinery for spinning wool, alone and mixed with other fibres. The possibilities of automatic winding and weaving are being studied, while research on bleaching and dyeing continues to have as its object the development of existing methods and investigation of new ones to improve the quality of the product. In finishing research, the study of the application of crease-resistant finishes to linen fabrics has figured prominently and the possibility of fixing both finishes and protective agents by chemical combination with the cellulose has been examined.

Some six hundred testing reports have been made to members, and much cloth testing, chiefly the measurement of tearing and tensile strength, has been undertaken in connexion with the development of new types of flax canvas. Special attention has also been directed to the influence of the micro-structure of flax fibres on the behaviour of flax materials, both during processing and in service.

EDUCATION IN AND FOR THE SERVICES

ALTHOUGH the education authorities of the three Services—Royal Navy, Army and Royal Air Force—frequently collaborate and meet to pool experiences and thrash out problems common to all, it was probably for the first time that all three met by invitation to present their case and reveal their main objectives and the problems which they entail to an audience of nothing but civilian educationists on July 14 at the Conference on "The Education of the Young Worker" organised by the Department of Education of the University of Oxford and held at Manchester College, Oxford, during July 12–17.

The case for the Royal Navy was presented by Instructor-Captain F. C. Sobey, director of studies, H.M.S. *Kestrel*, Winchester; that for the Army (Royal Army Educational Corps) and the Army Cadet Force by Brigadier W. G. Pidsley, deputy director of Army education, and Brigadier H. Kenyon, deputy director cadets, respectively; and that for the Royal Air Force by Group-Captain I. B. Hart, deputy director of education. The meeting was held under the chairmanship of a civilian, Mr. L. J. F. Brimble.

Mr. Brimble emphasized the exceptionally difficult problems which arise in Service education—problems which are often not appreciated by its critics. Now that the Services, particularly the Army, have to deal with National Service entrants, their subject-material is not just a cross-section of the public; indeed, it is almost the entire public at the age of 18–19 plus years. Service intakes at these age-levels include all grades of intelligence and all standards of educational attainment from illiterates up to university graduate level. In most areas there are not enough men or women to warrant segregation into groups according to standard of intelligence or achievement, so that frequently many different grades have to be taken together, though, of course, individual teaching and training are not overlooked. This is, perhaps, the greatest imaginable challenge to the ingenuity of the education officer or instructor. As an illustration, Mr. Brimble described a lecture-discussion which he recently led with Army men of Higher School Certificate standard and upwards, and compared this with a lecture he gave soon afterwards to a group of Army near-illiterates of ages 19–25 years in which only one had ever heard of Faraday and only two of Gladstone. In these two cases, he had his audiences segregated, which made matters much easier than they frequently are in the field.

Group-Captain Hart stated that in the Royal Air Force there are two main educational aims—education for the Service itself and education for the individual. Naturally one aim helps the other, so the distinction between the two is more imaginary than real, and both aims are integrated and correlated wherever possible. Education for the Service is compulsory, whereas that for the individual is mainly voluntary. By and large, the scheme works well in spite of two main difficulties: (1) the peripatetic nature of most Royal Air Force personnel which can frequently upset completely even the best-devised schemes, and (2) the lack of qualified instructors—a lack which is at present common to all educational projects, both Service and civilian.

Brigadier Pidsley gave a very lucid account of the recently planned scheme for the Army which, he emphasized, is still only of an interim nature since the Army itself has still to settle down to a peace-time footing. The Army absorbs the majority of National Service entrants (it is composed roughly of half regulars and half National Service men); but despite the movable nature of Army men and units and the shortage of trained instructors, the scheme, like that of the Royal Air Force, is getting well under way. Just as in the Royal Air Force, units are sent to many parts of the Commonwealth, etc.; but wherever they may be, the presence of the Royal Army Educational Corps is felt. Some units are isolated and there the ingenuity of the instructors is taxed to the limit; other units are near big towns where civilian educational facilities are available to Army men and women. The Army educational scheme is very flexible though it has three broad aims: (1) to make a man a soldier; (2) to train him in good citizenship; and (3) to enable him to develop along the best lines as an individual. Broadly speaking, Brigadier Pidsley claimed that the Army education scheme has got its horse to the water; now it is the job of the Royal Army Educational Corps to see that it drinks.

Speaking for the Army Cadet Corps, Brigadier Kenyon claimed that its educational and training scheme has a real moral purpose behind it and he described various means whereby this purpose is being achieved. The wide variety of interests, both cultural and vocational, inherent in such groups of boys is recognized and catered for so far as is possible. Though religion is recognized and encouraged, politics, and especially party politics, are not. Everything is dealt with on a voluntary basis; nothing is forced upon the boys.

As was clearly stated by Instructor-Captain Sobey in a stimulating yet amusing contribution, the case for the Royal Navy is somewhat different from those of the other two Services. The Navy has few problems arising as a result of the intake of National Service men because that intake is so small—at the rate of about two thousand a year. There is no ship, however, no matter how small or large, and no shore establishment, where there is not at least one well-qualified instructor, and in some ships such as large aircraft carriers and certain shore establishments there are several instructors. Training is, of course, mainly technical; but wider vocational and cultural interests are accepted and encouraged.

It was of interest to note that in all three Services current affairs and citizenship loom large and are compulsory. There are few subjects which appear in a civilian adult education programme which do not appear in the curricula of Service educational schemes. The ultimate aim of linking up and integrating Service education with the national civilian education should in due course be achieved with little or no difficulty.

FORTHCOMING EVENTS

Tuesday, July 27—Friday, July 30

SOCIETY FOR APPLIED BACTERIOLOGY (at Queen's University, Belfast).—Annual General Meeting and Summer Conference.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT IN THE AGRICULTURAL BOTANY DEPARTMENT, a LECTURER (Grade III) IN DAIRY CHEMISTRY, and an ASSISTANT LECTURER IN AGRICULTURAL CHEMISTRY—The Secretary, North of Scotland College of Agriculture, 41½ Union Street, Aberdeen (July 31).

LECTURER IN PHYSICS—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S.E.18 (July 31).

H.M. INSPECTORS OF FACTORIES—The Secretary, Ministry of Labour and National Service (O.E.11), 80 Pall Mall, London, S.W.1 (July 31).

SENIOR LECTURER IN CHEMISTRY, and ASSISTANT LECTURERS (one primarily in Botany and one primarily in Zoology) IN THE DEPARTMENT OF BIOLOGY—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S.W.3 (July 31).

LECTURERS IN (*a*) PHYSICS with subsidiary MATHEMATICS, (*b*) ELECTRICAL AND MECHANICAL ENGINEERING—The Chief Superintendent, Telecommunications Research Establishment, Great Malvern, Worcs. (July 31).

SECRETARY OF THE DEPARTMENT OF PHYSICS—The Cavendish Professor, Cavendish Laboratory, Cambridge (July 31).

RESPONSIBLE LECTURER IN ELECTRICAL ENGINEERING, a RESPONSIBLE LECTURER IN MECHANICAL ENGINEERING, and a RESPONSIBLE LECTURER IN CHEMISTRY—The Principal, Royal Aircraft Establishment Technical College, Farnborough, Hants (July 31).

ASSISTANT PHYSICIST—The Secretary, Royal Northern Hospital, Holloway, London, N.7 (July 31).

PSYCHOLOGIST—The Secretary, National Hospital for Nervous Diseases, Queen Square, London, W.C.1 (July 31).

ASSISTANT LECTURER IN THE DEPARTMENT OF GEOGRAPHY—The Registrar, The University, Leeds 2 (July 31).

ASSISTANT AGRICULTURAL ECONOMISTS (3, male)—The Secretary and Registrar, The University, Bristol (July 31).

FOULERTON RESEARCH FELLOWSHIP IN MEDICINE—The Assistant Secretary, Royal Society, Burlington House, Piccadilly, London, W.1 (August 1).

LECTURER IN PHARMACOLOGY—The Secretary and Registrar, The University, Bristol 8 (August 1).

PHYSICIST—The Secretary, British Jute Trade Research Association, Bellfield Street, Dundee (August 14).

POWER HOUSE SUPERINTENDENT in the Power House of the Fertilizer Factory, Sindri, Bihar—The High Commissioner for India, General Department, India House, Aldwych, London, W.C.2, quoting No. 333A. (August 14).

LECTURERS IN (*a*) ENTOMOLOGY, (*b*) GENETICS, and (*c*) INSECT PHYSIOLOGY, in the Department of Zoology and Applied Entomology—The Secretary, Imperial College of Science and Technology, South Kensington, London, S.W.7 (August 17).

SENIOR PRINCIPAL SCIENTIFIC OFFICER at the Royal Observatory, Greenwich—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2207 (August 20).

CHEMISTS (men and women) in the Grades of Scientific Officer Class and Experimental Officer Class, for analytical work in connexion with atomic energy development, under the Ministry of Supply—The Ministry of Labour and National Service, Technical and Scientific Register, K Section, York House, Kingsway, London, W.C.2, quoting F.78/48A/2 (August 24).

PRINCIPAL SCIENTIFIC OFFICER, and SENIOR SCIENTIFIC OFFICERS, in the Engineering Division of the Atomic Energy Research Establishment, Harwell, Berks—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2205 (August 26).

CHIEF TECHNICAL INSPECTOR in the Ministry of Pensions—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2218 (August 28).

ASSISTANT TO THE PROFESSOR OF BOTANY—The Registrar, Trinity College, Dublin (August 30).

KEEPER OF ANTIQUITIES—The Director, Museum and Art Gallery, New Walk, Leicester (August 30).

DIRECTOR (Professor or Reader) OF THE UNIVERSITY OF MADRAS BIOCHEMISTRY LABORATORY—The High Commissioner for India, General Department, India House, Aldwych, London, W.C.2 (India, August 31).

SENIOR LIBRARY ASSISTANT (graduate, preferably in Science or Economics)—The Registrar, University College, Southampton (August 31).

SCHOLARSHIP for training in INDUSTRIAL RESEARCH—The Director, Institute for Industrial Research and Standards, 45 St. Stephen's Green, Dublin (September 1).

MAMMALOGIST (male), and an ORNITHOLOGIST (male)—The Director, Transvaal Museum, P.O. Box 413, Pretoria, South Africa (September 30).

METEOROLOGISTS for the East African and West African Meteorological Services—The Director of Recruitment (Colonial Service), 15 Victoria Street, London, S.W.1.

LABORATORY ASSISTANT/STEWARD FOR PHYSIOLOGY—The Head of the Department of Biology, Chelsea Polytechnic, Manresa Road, London, S.W.3.

GRADUATE IN PHYSICS OR CHEMISTRY in the Intelligence Division for Literature Research—The Secretary, Research Association of British Rubber Manufacturers, 105 Lansdowne Road, Croydon.

LABORATORY STEWARD (Grade II)—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1.

RESEARCH STAFF in the categories of PHYSICS, CHEMISTRY (mainly Physical), and ENGINEERING—The Director, Gas Research Board, 1 Grosvenor Place, London, S.W.1.

PHYSICISTS to work on problems connected with the measurement of motion and forces in winding and weaving machines, and to investigate problems of cloth structure and serviceability—The Director, Linen Research Institute, Lambeg, Lisburn, N. Ireland.

LABORATORY TECHNICIAN (Grade C) IN THE BIOLOGY DEPARTMENT—The Warden and Secretary, Royal Free Hospital School of Medicine, 8 Hunter Street, London, W.C.1.

LECTURER IN THE PHYSICS DEPARTMENT—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1.

RESEARCH BIOCHEMIST IN THE DEPARTMENT OF PATHOLOGY—The Director of Pathology, Bernhard Baron Memorial Research Laboratories, Queen Charlotte's Maternity Hospital, Goldhawk Road, London, W.6.

LABORATORY ASSISTANT (man) at Westminster Secondary Technical School, Ebury Bridge, London, S.W.1—The Education Officer (Estab. 2), London County Council, The County Hall, London, S.E.1.

SPECIAL DEMONSTRATORSHIP IN THE DEPARTMENT OF BACTERIOLOGY AND IMMUNOLOGY (to work principally at St. Albans)—The Dean, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1.

RESEARCH STUDENTSHIPS IN THE DEPARTMENTS OF BOTANY, CHEMISTRY, PHYSICS and ECONOMICS—The Registrar, University College of the South-West, Exeter.

LECTURER or ASSISTANT LECTURER IN PURE MATHEMATICS, a LECTURER or ASSISTANT LECTURER IN PHYSICS, and a LECTURER IN ZOOLOGY—The Registrar, University College of the South-West, Exeter.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

University of Bristol: Department of Economics (Agricultural Economics). The Fruit Growing Industry in Kent. By L. Napolitan. Pp. 223–318. (Bristol: The University, 1948.) 5*s*. [185

Commonwealth Bureau of Horticulture and Plantation Crops. Technical Communication No. 19: Seed Production of European Vegetables in the Tropics. By A. G. G. Hill. Pp. 28. (Aberystwyth: Commonwealth Agricultural Bureaux, 1948.) 2*s*. [185

Commonwealth Bureau of Plant Breeding and Genetics. Technical Communication No. 14: Technique of Breeding for Drought Resistance in Crops. By T. Ashton. Pp. 34. (Aberystwyth: Commonwealth Agricultural Bureaux, 1948.) 2*s*. 6*d*. [185

Empire Cotton Growing Corporation. Progress Reports from Experiment Stations, Season 1946–1947; Programmes of Experiments, Season 1947–1948. Pp. ii+152. (London: Empire Cotton Growing Corporation, 1948.) 3*s*. [245

Other Countries

Proceedings of the American Philosophical Society. Vol. 92, No. 2: Studies of Historical Documents in the Library of the American Philosophical Society. Pp. 75–126. (Philadelphia: American Philosophical Society, 1948.) 1 dollar. [255

Annals of the New York Academy of Sciences. Vol. 49, Art. 4: Hemorrhage. By Gregory Shwartzman, C. H. Best, Robert Chambers, Charles S. Davidson, John H. Ferguson, Robert F. Furchgott, I. E. Gerber, Magnus I. Gregersen, Paul György, Russell L. Haden, C. Hyman, L. B. Jaques, Paul Klemperer, R. E. Lee, C. N. H. Long, Dickinson W. Richards, Jr., R. H. Schneider, Ephraim Shorr, Henry J. Tagnon, S. A. Thayer, Lee C. Underwood, Donald D. Van Slyke, Alfred E. Wilhelmi and B. W. Zweifach. Pp. 483–660+5 plates. (New York: New York Academy of Sciences, 1948.) 3 dollars. [255

Conference on Metabolic Aspects of Convalescence. Transactions of the Fifteenth Meeting, New York, March 31–April 1, 1947. Edited by Dr. Edward B. Reifenstein, Jr. Pp. 163. (New York: Josiah Macy Jr. Foundation, 1948.) 2.25 dollars. [255

Phytopathological Classics. No. 8: Observations, Botanical and Physiological, on the Potato Murrain. By M. J. Berkeley; together with Selections from Berkeley's Vegetable Pathology. Made by the Plant Pathology Committee of the British Mycological Society. Pp. 108. (East Lansing, Mich.: American Phytopathological Society, 1948.) 1.50 dollars. [255

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SCIENTIFIC METHOD IN THE CONSERVATION OF PICTURES

IN the Golden Age, Plato and Aristotle walked in the Academy and in the Lyceum, instructing and disputing. We, in our time, are in possession of much of their labours ; we have entered into them, and they have become part of our inheritance. Other searchers after truth there were too in those days—artists and craftsmen—who fashioned things for delight as well as for use. But alas ! less, much less, of their works have survived to the present day. In the case of paintings (originally a great number) next to nothing now remains. In due time, men of genius in applied science appeared, men who understood how to harness natural law to immediate needs. They had to combat the Platonic tendency to discourage investigations concerned with gross matter, and for centuries there had been the lag between discovery and application. But it may be that man was not then ready for such advances. Enough to recollect that when a giant appeared—in the person of Leonardo da Vinci—he combined consummate artist, engineer, technician and natural philosopher all in one. Perhaps sensing his own incapacity to generalize, he strove against heavy odds to study afresh the works of Archimedes, and thus, with not inconsiderable success, to effect a junction between studio and laboratory.

The centuries that have passed since then have taken heavy toll of man's cultural patrimony. No nation has escaped, though losses are probably less than some people imagine. But deterioration goes on without ceasing : here a little and there a little, until some irreplaceable masterpiece stands in real jeopardy. The duty of conservation is plain enough. How is it to be shouldered ? On p. 166 of this issue of *Nature*, Dr. W. G. Constable discusses the findings of the Weaver Commission, appointed last summer to examine the methods and results of cleaning pictures at the National Gallery.

In outline, the report of the Weaver Commission goes far, perhaps as far as it is permissible to go, in the direction indicated by the terms of reference. But its significance lies much deeper. For it is a wider concept than what has happened or not happened to certain pictures that is involved. It is nothing less than the place of scientific method in the task of conservation ; and it may be said at once that the report provides full vindication for its introduction. Clearly, every consideration and weight must be accorded to æsthetic principles (and at a certain stage of operations these may well be crucial) ; but when all is said and done, supreme paintings are physical objects and subject to all the limitations, stresses and strains to which such things are prone. Restoration connotes much more than 'cleaning' ; a branch of knowledge now known fairly widely as 'picture-mechanics' is indicative of the temper of responsible people who strive to understand, and then to use, the advancement of laboratory techniques for the benefit of the national collections. They are not in the least inclined to wander into other people's gardens, where they may or may not be welcome: their sole function, as they see it, is to bring to bear every kind of scientific device and experience, and to use them impersonally and impartially in the service of conservation. Again, just as the ablest physician or surgeon will realize that his patient has a personality, and that recovery from illness and sound health thereafter are closely connected with it, so the man of science in the service of the arts appreciates that a great picture was made and exists for glory and for beauty, for the enjcyment of mankind. Manifestly, the responsibility of the authorities is to the future, as well as here and now.

Realizing this, the Weaver Commission stressed the need for air-conditioning as the most important single item among those calculated to preserve the pictures in the National Gallery in the interests of posterity. Shortly after the pictures were returned from their war-time exile in Wales, the Ministry of Works, in consultation with the Trustees and Gallery officials, started to prepare plans, and intensive study of the problem—by no means an easy one in the case of such a building as that in Trafalgar Square—has been going on continuously. It is understood that, in fact, a start has already been made with the erection of the room for the necessary equipment, and much of the machinery is already on the site. Naturally, every opportunity is being taken to learn from experience, by visits and so forth to installations, both in Great Britain and overseas. The project is of necessity being conducted in stages; and there can be little doubt that a most efficient scheme will emerge in the end. Advantage is being taken of the atmospheric pollution tests made in the Gallery during 1936–37 to guide the engineers in the filtration problem; for there is no reason for thinking that the data to-day are appreciably different from those of twelve years ago. Similarly, observations already exist relating to the moisture-content of panel paintings (that is, those executed on wood) both in the public galleries and elsewhere. These figures are of considerable importance in calculating the limit between which it is desirable for the relative humidity to be stabilized.

For some months past, preliminary plans have been maturing for the more exact registration of the dimensional change in wood and fabric supports as a function of relative humidity and temperature. The experiments have been designed to reproduce as nearly as possible the actual conditions obtaining in a picture and should yield valuable information relating to warping, cracking and flaking.

These activities are perhaps but a fraction of the scientific care of paintings. An indication of the problems involved is given by Mr. F. I. G. Rawlins, scientific adviser at the National Gallery, in an article, with illustrations from some of the 'cleaned' pictures, which is published in the July issue of *Endeavour*. It is quite clear that no single institution can hope to tackle all the problems presented by an attempt to look after great pictures adequately. Before the War—in fact, ever since the research laboratory of the National Gallery was established in 1935—the policy has been to work in close co-operation with the Department of Scientific and Industrial Research. Broadly, the task is twofold: the application of scientific processes (mostly physics) to the pictures themselves, and next the 'farming out' of questions relating more to the materials from which pictures are constructed and the control of the environment. The fusion of both lines of inquiry should lead (and indeed has led) to a much fuller understanding of the whole subject. In the main, the first type of work is undertaken in the National Gallery laboratory itself; whereas the second is carried on in such establishments of the Department of Scientific and Industrial Research, and sometimes of the research associations, as convenience may suggest. In all cases, the Gallery laboratory is in control of operations and co-ordinates them all. Further, the Gallery has the unique advantage of the services of an Advisory Scientific Committee. This is an honorary body of six distinguished men of science who meet quarterly in order to help in whatever way they can in the application of scientific methods, both in conservation and as an aid to historical research. It was set up by the Trustees fourteen years ago, with the scientific adviser of the National Gallery (who is also in charge of the research laboratory) as secretary, and it is noteworthy that, apart from work on conservation, these years have seen valuable studies of æsthetic as well as scientific aspects of the pictures in the Gallery.

The result of all this is difficult to assess, since it is still something of a novelty and in the formative stage. But two tendencies are beginning to take shape: one (the short-term aspect) the value of an exact scientific and technical approach and control applied to the National Gallery's problems as such; and the other (the long-term view) a definite bridging of the gap that has so long separated the arts and sciences from one another, to the detriment of both. It is no less through doing than through thinking that the scholar and craftsman, technician and artist, can come to appreciate each other in a common quest for the beautiful.

FIBIGER: PIONEER OF EXPERIMENTAL CANCER

The Danish Cancer Researcher, Johannes Fibiger, Professor in the University of Copenhagen

By Prof. Knud Secher. Pp. 206. (Copenhagen: Arnold Busck; London: H. K. Lewis and Co., Ltd., 1947.) n.p.

THE first part of this book recounts Fibiger's ancestry back to 1667: some of his ancestors, including his father, were medical men; but they seem to have made no striking contributions to scientific knowledge. Fibiger's youth was not altogether happy, since his father died when he was a child and his mother was put to some difficulty to educate the children and had little time for the affection that might have softened Fibiger's character. His early history perhaps explains his rather moody nature, particularly in his early adult life, when, no doubt, he had to contend with the usual difficulties common to many medical men. But he seems to have been happy in his professional career, and writes enthusiastically of his early training with

Prof. Salomonsen, who gave him a comprehensive training in bacteriology which stood him in good stead in his later work.

The second part of the book deals with his professional life up to the time that he made his discoveries of the relationship between infestation with the *Gongylonema neoplasticum* and tumours in the stomachs of rats. His first scientific period was mainly concerned with controversies about the pathogenicity of bovine strains of tubercle bacillus. In this work Fibiger found himself in opposition to Koch, who belittled the importance of bovine infection as a source of human disease. Fibiger and Jensen upheld, successfully, the importance of the bovine strain, and at numerous international congresses he made his case so successfully that he rapidly acquired an international reputation.

During this same period, Fibiger came to hold leading positions in the medical and scientific world in Denmark, and in 1907 was elected to the Cancer Committee, which was originally formed to investigate cancer of the uterus. His influence was soon felt on this Committee, of which he became vice-president in 1908. He sponsored a questionnaire to all Danish physicians, dealing with the incidence of cancer, and obtained replies from 99 per cent of them. In 1909 he instituted a system of free microscopical diagnosis for which he was largely personally responsible. In the next few years he obtained cancer censuses from the Faroes, Iceland and Greenland, which yielded the interesting result that the incidence in the Faroes and Greenland resembled that in Europe, whereas in Iceland it was only about half as high. About this time, a chance observation diverted his attention to experimental cancer investigation, which made his name famous throughout the scientific world, and won for him the Nobel Prize in 1928.

The third part of the book deals with the development of this research, and is not only a convenient collection of facts which are not readily available to English readers, but is also a defence of Fibiger's conclusions by Secher against the criticisms that have been made since his death. There are numerous illustrations of the nematodes, of the cockroaches which are their intermediate hosts, and of the gross and microscopic pathological lesions observed by Fibiger, both in wild rats and in those experimentally infested. One can well understand how he reached his conclusions, on the available evidence, and in the light of scientific knowledge at that time; but despite the enthusiasm with which Secher supports the work of his friend, it cannot be said that he does much to strengthen the case as presented by Fibiger himself. It is unfortunate that fire destroyed the sugar factory in which the wild rats infested with nematodes were found with tumours in their stomachs. Even the most careful attempts by Passey and his collaborators to reproduce the conditions of Fibiger's experiments may have failed in some important but apparently trivial circumstance to reproduce exactly the conditions in Fibiger's laboratory. Secher stresses the heavy infestation held by Fibiger to be essential for the induction of tumours, and not realized by others repeating the work. The reviewer cannot escape the conclusion that some of the tumours seen by Fibiger were genuinely malignant; but only benign tumours and hyperplasia have been recorded by others who have tried to repeat his experiments. There seems little doubt that some, at least, of the alleged metastases in the lungs were probably instances of metaplasia in bronchiectatic cavities, as clearly demonstrated by Passey *et al.* Secher illustrates, on p. 133, such a lesion as a "pulmonary metastasis"; but on the same page is a low-power photomicrograph described as a "glandular metastasis", which looks like a keratinizing squamous carcinoma. The tumours that were maintained by transplantation in Fibiger's experiments seem to have qualified as malignant.

Secher succeeds in convincing the reader of Fibiger's integrity, and of the great thoroughness with which he pursued his investigation. He seems to have left nothing to chance, and to have been highly critical of his own results. If he failed to give a completely satisfactory explanation of them, that must be attributed to lack of knowledge of the influence of vitamins and other factors on hyperplastic lesions, in the period about the time of the First World War, when this work was done. It must be said, however, that there are many irritating features in this book. It is written in English, and yet it is filled with the most curious phrases and words, which make the meaning obscure. For example, the stomach is referred to as the 'ventricle' very frequently, and a number of strange words occur throughout the text. Fortunately their meaning is usually clear, as, for example, "irritaments", "cancerated", and so on. The spelling of foreign names varies from page to page, and even on the same page. It would have been of considerable advantage to the reader if the text had been edited by an Englishman before publication.

P. R. PEACOCK

CLOCKS AND WATCHES

Horology

The Science of Time Measurement and the Construction of Clocks, Watches and Chronometers. By J. Eric Haswell. With Supplement. Pp. xvi+288+19 plates. (London: Chapman and Hall, Ltd., 1947.) 16*s*. net.

IT is now about eight years since the previous edition of this book was sold out, and a measure of the esteem in which it was held by horologists is that second-hand copies were unobtainable. Its reappearance is therefore very welcome. The book commences with a clear exposition of the fundamentals of time and time measurement, which are treated at considerably greater length than is usual. The section on pendulums deals principally with those types used in precision clocks; it is unfortunate that the question of temperature compensation and temperature errors is not treated quantitatively, as this does not require difficult mathematics, such as the author has evidently taken much trouble to avoid. Also there is no mention of the magnitudes of circular and barometric errors. A point of terminology which seems doubtfully correct is the use of the term a 'free' pendulum, since all clocks described as having 'free' pendulums have their pendulums, in fact, coupled to constant-force escapements of one kind or another. The term, however, has a wide usage among horologists, and it is perhaps as well to retain it.

Clock and watch escapements are treated in Chapters 4 and 14; here, unfortunately, the author deals only with special cases of escapement lay-out and proportions. In the case of the lever and cylinder watch escapements, this is not very serious, as their designs are fairly stereotyped nowadays; but in cases such as the dead-beat and recoil clock escapements, which may, in fact, be constructed with widely varying proportions, the information available is not of much use. Also references to the impulse tangent circle are misleading, since impulse is, in fact, delivered at right-angles to these lines, and in most of the drawings of clock and lever watch pallets there are small but nevertheless important geometrical errors.

Gearing is dealt with in Chapter 5, and in the supplement, and an interesting section has been included on epicyclic trains for revolving-escapement watches. There is a very useful section on the balance and spring, covering both the questions of temperature and positional errors; the supplement includes a section on modern hairspring alloys.

A good description of striking and chiming mechanisms, general lay-outs of clocks and watches, and much interesting and useful information on complicated watches, such as chronographs, calendars and repeaters, with a good chapter on the marine chronometer, combine to make this book very useful and informative to those interested in horology from a descriptive point of view. R. A. FELL

LABORATORY ORGANIC CHEMISTRY

Newer Methods of Preparative Organic Chemistry

Translated and revised from the German. (Published and distributed in the Public Interest with the consent of the Alien Property Custodian.) Pp. xiii + 657. (New York and London: Interscience Publishers, Inc., 1948.) 8.50 dollars; 51*s*.

Semimicro Qualitative Organic Analysis

By Nicholas D. Cheronis and John B. Entrikin. Pp. xiv + 498. (New York: Thomas Y. Crowell Company; London: Constable and Co., Ltd., 1947.) 25*s*. net.

Reactions of Organic Compounds

By Dr. Wilfred John Hickinbottom. Second edition. Pp. x + 482. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1948.) 25*s*. net.

THESE three books cater for the needs of the student and the worker in organic chemical research.

"Newer Methods of Preparative Organic Chemistry" comprises fourteen articles each written by a German expert, which have been translated and revised by American chemists. It thus presents the reader with authoritative accounts of the application in the laboratory of a number of the most useful of modern methods and special reagents. Oxidations using lead tetra-acetate or periodic acid and dehydrogenations with sulphur, selenium or platinum and palladium catalysts are described. Catalytic reductions with Raney nickel or copper chromite are reviewed in detail. Another chapter is devoted to oxidations and reductions in presence of aluminium alkoxides. An account of biochemical oxidations and reductions deals with the employment for preparative purposes not only of micro-organisms but also of higher animals.

Other sections of this book discuss various substitution reactions of aliphatic substances, the chemistry of organic fluorine compounds and the uses of boron fluoride and hydrofluoric acid in organic reactions. The fact that the chapters on diene syntheses and the uses of diazomethane were written by Alder and Eistert respectively is a guarantee of their excellence, and in conclusion an account is given of the uses of organolithium compounds.

The volume is an excellent and timely production which will be of great service to the research worker.

"Semimicro Qualitative Organic Analysis" aims at providing a general course in qualitative organic analysis for students, and a manual and reference book for workers in all types of laboratory, whether academic, professional or industrial.

The rapid expansion of our knowledge of the chemistry of biological materials has been largely due to the use of microchemical methods, the advantages of which are generally recognized, and the research worker in organic chemistry must sooner or later acquire the necessary technique. The principle adopted by the authors of this book is that the student should learn to work on the semimicro scale in the organic laboratory from his first year, and the advantages in economy of material and valuable training are obvious. All the necessary operations and equipment are, therefore, described at the outset, and the rest of the book gives a systematic procedure for the identification of a substance, special emphasis being placed on observations of solubility. Suitable derivatives are listed for each class of compound and exact directions are given for their preparation and careful purification on the semimicro scale.

Numerous lists of selected references are included, and the book concludes with a valuable collection of tables of compounds arranged in classes in order of melting or boiling point together with particulars of various derivatives or figures for physical properties such as density, refractive index or rotatory power to assist the identification. A final table includes many more complex bases, drugs, vitamins and hormones.

This volume will not only be useful to the student, but will also prove most valuable as a book of reference.

A new and revised edition of Hickinbottom's "Reactions of Organic Compounds" will be generally welcomed. It reviews in detail the reactions of all the main classes of compounds and gives in an appendix a scheme for their identification. New material has been added, particularly in the sections on saturated and unsaturated hydrocarbons, on organolithium compounds and on the uses of diazomethane. The book is a valuable source of information with many preparative details, and it is packed with references to the literature.

APPLIED SURFACE CHEMISTRY

Surface Chemistry for Industrial Research

By J. J. Bikerman. Pp. ix + 464. (New York: Academic Press, Inc.; London: H. K. Lewis and Co., Ltd., 1948.) 8 dollars.

THE author states in his preface that "This volume is an exposition, adapted to Industrial Research, of the fundamentals of Surface Science". In fact, it is nothing of the sort; it is an assemblage of data of surface phenomena with the fundamentals badly scamped. Too frequently also, the author introduces a topic with a definite statement and then proceeds to cite reservations and evidence against it without afterwards summing up. The reader is left confused.

The book is comprehensive ; it has the conventional subdivision into liquid–gas, liquid-liquid, solid-gas, solid-liquid-gas, solid-liquid–liquid, and a final chapter on electric surface phenomena. It is extremely well and thoroughly documented and the international scope of the references is most praiseworthy. Taking a chapter at random, out of 284 references, 23 were to books, 71 to technical journals and, of the remainder to academic publications, 45 were German, 51 British, 23 Russian, 21 American and the remaining 50 assorted European. As usual, of course, this completeness of bibliography has led to lack of critical assessment and to citing papers which will be found to add nothing to accepted statements. It has also led to a curious tendency to cite results obtained from rather exotic systems without enough data upon simple ones and common substances. To give examples, the section of four pages on unimolecular films contains a statement that "Since the length" (of what, is not stated) "does not differ much from the length of an 'oil' molecule, films of a similar or smaller thickness are termed unimolecular". This is all the introduction to this important branch of surface chemistry that the author gives to the industrial worker. No force/area curves are reproduced. Shortly afterwards, foams receive 14½ pages.

The section on emulsions is a good example of the second chief fault of the book, namely, that of making an exact statement and following it by a collection of reservations, usually showing noticeable critical thought. The diagrams are unusually well designed and drawn, but the type used for numerals in the text is bad and the '2' is a continuous offence to the eye.

This miscellany should be welcomed by those lecturers who like to enliven their teaching with references to practical applications and perhaps by students wishing to heckle their lecturers. It cannot be recommended to anyone else, which is a pity, because the book does contain much acute and critical thought.

Compilations of this sort are nothing new ; they are a sort of crude operational research in technology which has been practised for centuries. Another recent book in this same field—"Emulsions and Foams", by Berkman and Egloff—is an example of work of this character in its extreme form, unadulterated by critical discussion or theoretical foundation. Such authors can properly retort, especially in the case of emulsions, that there exists no such fundamental foundation and that their books are a criticism of, and a challenge to, academic workers. Here the Irishman's definition of a net as a lot of holes tied together with bits of string is apt. Fundamental theory and experiment is the string ; somewhere in the holes is the practical application ; some of the holes are very large ones, especially in a science of such recent growth as surface chemistry. Applied science cannot alone fill them, and fundamental work must do more to bridge the gaps. Their co-operation, however, is not encouraged by publication of masses of facts and figures not correlated with any organised net-work of knowledge, and not capable of being so correlated because they are observed without any intention of seeking such correlation.

Books of this sort are an indictment of the failure of academic workers to come down from their 'ivory towers' and help to clean up the mess ; but they also indict the applied worker in industry, often engaged as a research worker. There are far more of these in industry than there are in the universities ; they are able men ; they have more time and often better facilities for research. Why do they not play a more serious part in bridging the gap between pure and applied science ? Why is this serious wastage tolerated ? Perhaps because the 'practical' man is in charge and he says : "cut out the theoretical stuff and tell me how it works". Bikerman's book will appeal to such so-called practical men.

A. S. C. Lawrence

THE SCIENCE OF NUTRITION

Science and Nutrition

By A. L. Bacharach. Third edition. Pp. xii+142. (London : Watts and Co., Ltd., 1947.) 6*s.* net.

THE usefulness of this book, and its success, are sufficiently well attested by the fact that it has now run into its third edition. The scope is well indicated by Sir Jack Drummond, who in the preface to the first edition published in 1938 wrote that it should be read "not only by the intelligent 'man-in-the-street', whom for no very clear reason one assumes to be a layman, but also by the medical profession, until quite recently lamentably behindhand in recognizing the significance of experimental dietary studies, and perhaps even by the politicians who are at the moment very timorously testing the strength of 'nutrition' as a party plank".

A second edition, thoroughly revised and in many parts rewritten, was published in 1944, when the author wrote : "The last five years have shown a very marked change in the attitude of the public to the problems of nutrition. An enlightened Ministry of Food of which the effectiveness was no doubt in large measure due to its youth and its freedom from the trammels of precedent ; to a Minister who not only understood human nature, but also appreciated the value that science can have for the community ; to a scientific adviser—the writer of the Preface to this book—whose grasp of practical possibilities proved as shrewd as his knowledge of nutritional science was wide and flexible, and whose practical and scientific services have, since this book was first published, been fittingly rewarded by Knighthood and the Fellowship of the Royal Society ; last, but by no means least, to a Public Relations policy that has been as persistent and enthusiastic as it has, generally, been honest and intelligent : all these factors have helped to make tens of thousands of people realize for the first time that eating and drinking may be as important in their effects on our physical health as a few have always realized them to be on our spiritual well-being".

That is very true, and well said ; and what is equally important now is that the ground gained during the War should be extended further, and that public opinion should continue to be enlightened. In that aim, anyone seeking a balanced and interesting introduction to the science of nutrition can be recommended unhesitatingly to study this book. The new edition contains a number of minor changes and corrections and also a brief new allusion to folic acid, research on which has led to such remarkable developments since 1944.

CLEANING AND CARE OF THE NATIONAL GALLERY PICTURES

By W. G. CONSTABLE

Curator of Paintings, Museum of Fine Arts, Boston, Mass.

NOW that the dust of controversy over the cleaning of certain National Gallery pictures has to some extent settled, it is possible to judge some of its results. The ineptitude of much of the criticism should not blind us to its value. Apart from witnessing how greatly some of the owners of the pictures care about them, both the praise and blame meted out to the National Gallery authorities have revealed a fundamental confusion of thought over the cleaning of pictures—confusion between how a painting looks after treatment, and how its physical condition has been affected. Whether the spectator likes the appearance of a painting is a matter of taste, whereas its physical condition is a matter of fact; but only too often those who by habit or conviction like to see paintings as in a glass darkly make reckless charges of removal of original glazes, abrasion of surface and so on. That is not to say that criticism of appearance is unjustifiable. Pictures are meant to be looked at, and when all excrescences such as dirt, discoloured varnish and later repaints have been removed, a painting does not necessarily look as the artist meant it to look. Colours may have changed; there may be breaks in the surface; cracks may have developed; the pigment layer may have become more transparent with time, revealing the painter's earlier intentions or, in the case of paintings on a dark ground, causing the tone of whole areas to be lowered and so obscuring detail. It therefore becomes a problem for those in charge of paintings to decide what should be done in such cases; and the decision will range from merely 'in-painting' with a neutral colour the most obvious and disturbing breaks, to an elaborate tinting out of all blemishes and the use of a toned varnish, or retention of some of the old, to unify the whole. One thing is certain, however, we can never be quite sure how the painter intended his work to look; and since succeeding generations will have their own opinions on the matter, anything added to or left on a painting in the interests of appearance should be incapable of doing harm, and should be easily and safely removable.

This particular problem, however, was only raised by implication during the controversy; and both the National Gallery authorities and the Committee of Confidential Inquiry appointed by the Trustees have confined themselves to the question of the physical condition of the pictures, and how it has been affected by cleaning, both recently and in the past. The National Gallery presented its case in the form of the "Exhibition of Cleaned Pictures", which was reviewed in an article in *Nature* of October 18, 1947; and what follows is concerned only with the Report of the Committee. This consisted of Dr. P. Coremans, head of the Central Laboratory, Belgian National Museums; Dr. G. L. Stout, former head of the Department of Conservation, Fogg Museum of Art, Harvard University, now director of the Worcester Art Museum, Massachusetts; and Dr. J. R. H. Weaver, president of Trinity College, Oxford, who acted as chairman. It is difficult to imagine a committee technically better equipped, and more independent and judicially minded; and the report should become a *locus classicus* on certain aspects of cleaning. Presumably for reasons of economy, the report has not been published, but mimeographed copies may be consulted at the Victoria and Albert and the British Museums; an article on the report by Dr. Weaver appeared in *The Times* of May 8.

The report falls into two main parts. The first gives the results of intensive examination of ten recently cleaned pictures of diverse types, including all those the cleaning of which has been most severely criticized, notably Rembrandt's "Woman Bathing", Rubens' "Chapeau de Paille", and Velazquez's "Philip IV when elderly". The second part summarizes the results of this examination, and makes a series of recommendations on future practice and policy in cleaning, and on general measures for conservation. In the examination of the ten selected pictures, not only were all available records of cleaning taken into account, but also the criticisms and comments which have been made in the Press. The broad result cannot be more succinctly stated than in the words of the report. "In the ten pictures which were examined no damage was found to have resulted from the recent cleaning either because of a partial solution of original paint or because of abrasion or rubbing of original paint at the time when extraneous materials were removed from it." As regards particular pictures, of the Rembrandt it is said, "Adverse comments . . . centered on alleged damage, during recent cleaning, to the proper right wrist and hand. There is no evidence to support the view that such damage has occurred"; the conclusion concerning the Rubens' "Chapeau de Paille" is that "the procedure in the cleaning of 1946 seems to have been sound; there is no evidence of loss at that time or of any substantial deposits of extraneous material left on the original paint"; while of the Velazquez it is said, "Losses in the paint are minor ones and all were present before the cleaning began in 1946. Part of the former surface coating still remains. There is no evidence of any damage from recent treatment."

All this is interesting enough in itself and most reassuring. But equally interesting are the methods by which the conclusions were reached. The Committee was presented with a new type of problem. Analysis of a painting to ascertain its present physical condition, by such means as X-ray, ultraviolet light, microscopic and chemical analyses, etc., is nowadays standard procedure; but to discover what, if anything, had been removed from a painting at different periods in its history meant adapting these methods of investigation to new uses, and inventing others. A procedure used in every case was to test the solubility of the original paint layer with various solvents. This varied according to whether a resin had been mixed with the oil medium; but in all cases the original paint layer resisted much stronger solvents than those recorded to have been used in the recent cleaning. Close examination of the structure of the paint layer also proved valuable. In the "Chapeau de Paille", for example, a greenish-blue paint visible in part of the sky was alleged by a critic to have once covered the blue of the sky as it now appears; but this greenish-blue is now proved to be below the blue, which was applied in places to modify it. To estimate whether a surface had been abraded, comparison with areas which could reasonably be regarded as in their original state was the standard test. X-ray photographs taken in the past were a means of judging whether paint that had been removed was original or a later re-paint, notably in the case of the Rembrandt; and ultra-violet light was extensively used to ascertain whether, in areas alleged to have been damaged, old varnish still remained. Occasionally, as confirmatory evidence, the material in swabs used in cleaning a painting was analysed. In one case, at least, zinc white was discovered—a pigment unknown at the date of the painting, and so an indication that a later re-paint had been removed. Rightly, however, the report discounts the value of such evidence, owing to the difficulty—often impossibility—of distinguishing original pigment from that used later.

Though the report thus completely vindicates the National Gallery authorities on the main charges brought against them, it has also found occasion for some mild criticism. One ground for this, which may prove disconcerting to those who have assailed recent cleaning, is that some pictures, notably the Rubens' "Brazen Serpent", "Autumn: The Château de Steen", and "Peace and War", have not been cleaned enough, either in the interests of safety or of appearance. Old varnish or re-paints left on a picture are potential agents in disrupting the original surface, and if softened by partial cleaning may penetrate deeper into the interstices of the original paint, and so increase the difficulty of their removal, and their power to do harm; while their effect in throwing part of the painting out of tone may be considerable. In this connexion, the report brings out the difficulty of removing an old varnish or a re-paint, if the medium used by the artist contains a resin similar to that present in the extraneous elements, since the solvents used for removal may attack the original pigment layer. This danger was diagnosed by Faraday so long ago as 1853, and creates a difficulty in cleaning Constable's "Cornfield". In fact, in this picture and Rubens' "Rape of the Sabines", while noting the presence of extraneous and therefore possibly deleterious elements, the Committee holds that "special problems encountered in the process of cleaning would be considered to warrant accepting the present state as the best that could practically be reached".

Considerations of this kind lead to the more general conclusion that "materials used for cleaning . . . can be considered safe or unsafe only with respect to a particular piece of paint", and that "it is not even certain that the same solvent . . . can be considered quite safe over the entire area of one picture. In any part of a picture, safety is relative to other factors, particularly to timing and manipulation." This emphasizes how important is full diagnosis before a painting is cleaned. X-ray, ultra-violet light, infra-red rays, the tintometer, analysis of pigment layer and varnish, experimental tests in unimportant areas, must all be made and their results checked against each other. No one man can be expected to apply all these means of investigation; and so the system of modern medical practice must be followed, of specialist reports being put at the service of the man in charge, the cleaner. He, too, should be the centre of another set of specialist researches concerned with the materials he uses. Much has been discovered about solvents and protective coating materials; but much remains to be done in selecting and adapting them for use on paintings. In the last resort, however, it is the wisdom and skill of the cleaner which count. The scientific investigator can give him the facts, but he has to interpret them, estimate their significance and act upon them. In incompetent hands, any materials can do harm to a painting, especially if camouflaged by a little scientific knowledge; and the ideal cleaner adds, to wisdom and skill, sensibility and integrity. It is easy to produce a result which will fool for a time anyone save an expert, but which has either damaged the painting or sown the seeds of future trouble. The cleaner's responsibilities, moreover, do not end with cleaning. The report emphasizes the necessity of full and precise record, not only of diagnosis but also of treatment, as an indispensable guide to possible future action; and in preparing such a record the cleaner must play a leading part.

Another criticism suggested is the need for greater attention to the supports of paintings. It is not always sufficiently realized that an oil painting consists of several layers: the support, usually canvas or panel; the ground; the pigment held in a medium; and the protective covering. Each of these layers is liable to expand, contract or disintegrate on its own account, and thereby affect the appearance and condition of the painting; and imperfect bonding between the layers may intensify the trouble. Cleaning, in the ordinary sense of the term, is concerned with the protective coating and the pigment layer alone, in the interests of safety and of enabling the picture to be seen at what is thought to be its best. But properly considered, cleaning is only one part of the business of keeping every element of a painting in good health. Treatment of the supports of painting, however, requires more investigation and thought than it has hitherto received. It is not so long ago, for example, that glue was the universally accepted adhesive for attaching a new canvas on the back of an old one (the process known as 'lining'); while defective panels were always 'cradled', that is, secured on the back by a series of criss-cross slats. Both methods are now known to be at best unsatisfactory, and at worst dangerous; but though they are now falling into disrepute, no completely satisfactory substitutes have yet been found. It is to be hoped, therefore, that any campaign to put the supports of National Gallery paintings in order will be tentative, and based upon experiment and research.

One step, however, can be taken at once which can only have the most salutary results, that of controlling temperature and humidity conditions in the National Gallery. Experience in the quarry at Manod, where the paintings were stored during the War, proved how beneficial such control can be; while the disastrous effect of its absence is demonstrated by the cracking and warping of the panel on which Rubens' "Autumn: The Château de Steen" is painted, during the hard frost of January 1947. Let no one think, however, that air-conditioning is a complete answer to the problem of keeping pictures in good health. In a public gallery, the public themselves introduce variable elements of heat and humidity, which so far no system has been able to control. But it will not be the least of the services of the Committee of Inquiry to the public, if its recommendation that full air-conditioning be installed in the National Gallery is accepted and speedily implemented by those responsible.

OBSERVATIONS ON THE PRODUCTION OF MESONS BY COSMIC RADIATION

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In examining photographic plates 'exposed' to cosmic radiation at a height of about 10,000 ft. on the Jungfraujoch and the Pic du Midi, and at about 18,000 ft. on Kilimanjaro and Chacaltaya, we have now observed twenty nuclear 'explosions' which are accompanied by the emission of slow mesons. In this communication we give a number of photomicrographs of the tracks of these 'ejected' mesons. An analysis of the observed secondary effects which they produce enables us to show that at least the majority of them interact with nuclei and are therefore negatively charged; and that on the average they produce more vigorous nuclear disintegrations than most of the negative mesons which stop in the emulsions after being generated outside it. The main features of our present knowledge of charged mesons, with masses in the interval from 100 m_e to 400 m_e, can be accounted for in terms of two types of particles of different mass[1,2], which can be either positively or negatively charged, the heavier being generated in processes associated with the explosive disintegration of nuclei, and decaying spontaneously to produce the lighter ones. The possibility is not excluded, however, that the phenomena are more complicated than has been visualized hitherto.

In discussing the new material, we employ the previous classification of the different types of mesons recorded by photographic plates, which is based on their observed behaviour at the end of their range in the emulsion[2]. Thus we use the term 'σ-meson' for any particle, with a mass intermediate between that of a proton and an electron, which leads to the disintegration of a nucleus with the emission of one or more heavy particles of which we distinguish the tracks. Similarly, a 'π-meson' is one which, at the end of its range, gives rise to a secondary meson, of range $\sim 610\,\mu$ in the emulsion, the secondary particle being referred to as a 'μ-meson'. In addition, it is convenient to distinguish, by the symbol 'ρ', those mesons which enter the emulsion at the surface or from the glass of the plate, and which give rise to no observed secondary particles. It is certain that the different categories of particles thus defined are not all homogeneous. The ρ-mesons, for example, must contain a large number of both positive and negative particles; and we may also include among them some π-mesons of which we fail to distinguish the track of the associated μ-meson. It is nevertheless desirable to retain this phenomenological classification at the present stage in the development of our knowledge.

There are two features, peculiar to the photographic method of detecting nuclear particles, which are of importance for the present experiments. A particle, with a given initial energy, is brought to rest in a solid material in a time interval about two thousand times shorter than the corresponding period when it is moving in a gas. A meson, for example, with an initial energy of 4 MeV., is stopped in a photographic emulsion in about 10^{-12} sec., as compared with 5×10^{-8} sec. in normal air. It follows that it is possible, in principle, to arrest particles in an emulsion, and to study any secondary effects, associated with the emission of heavy charged particles, which they produce at the end of their range—even although their 'life-time' is so short that when moving in a gas or a vacuum they would, almost certainly, decay 'in flight'.

In contrast with this extremely extended 'time-scale', the powerful 'integrating' property of the photographic method—its continuous sensitivity—sometimes gives rise to difficulties owing to the chance juxtaposition of unrelated events. As an example, Fig. 1 shows a mosaic of photomicrographs in which the 'stars' A and B are joined by a common track τ. At first sight it might have been concluded that the two events are associated, but a closer inspection indicates that the two stars represent two separate nuclear explosions; and that the particle τ, which originated in star A, passed by chance near the centre of star B. This interpretation depends upon the observation that the two portions of the trajectory, τ, on either side of star B, are precisely in line; that there is no significant change in grain density in the two portions of the trajectory near star B and on either side of it; and that the track does not pass precisely through the centre of star B, but at a distance of about $2\,\mu$ from it. While events of this type are very rare, they emphasize the need for caution in interpreting the observations made with photographic plates, and the importance of bearing in mind the possibilities of confusion due to the

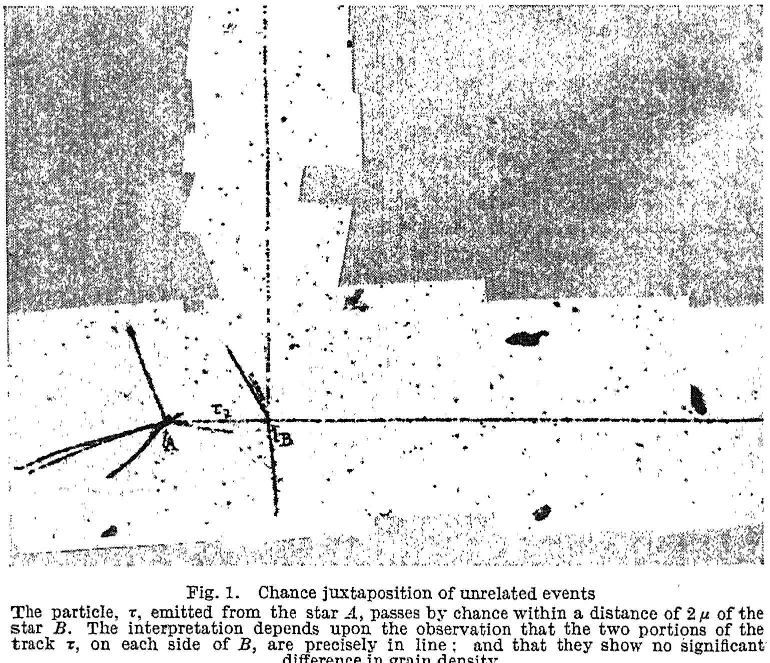

Fig. 1. Chance juxtaposition of unrelated events
The particle, τ, emitted from the star A, passes by chance within a distance of $2\,\mu$ of the star B. The interpretation depends upon the observation that the two portions of the track τ, on each side of B, are precisely in line; and that they show no significant difference in grain density
Observer Miss P. Dyer Exposure Jungfraujoch

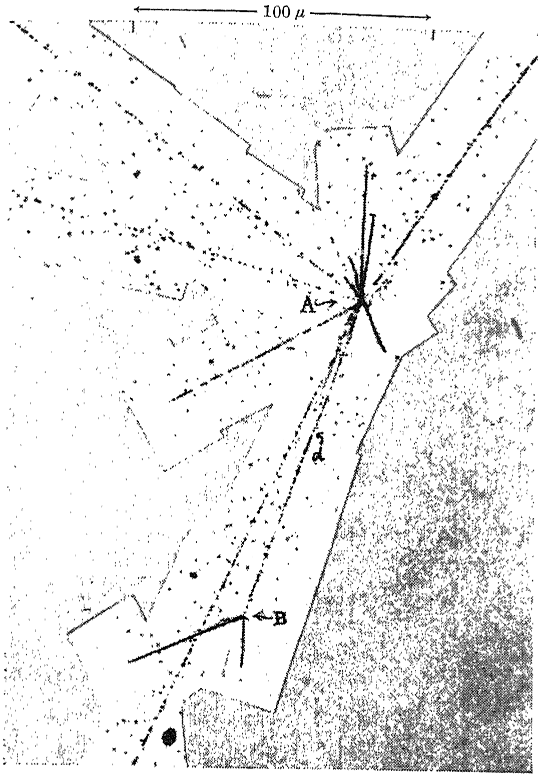

Fig. 2. Secondary disintegration produced by a particle emitted during the explosive disintegration of a nucleus. We assume that the particle producing the track *d* originated in star *A*, and collided with a nucleus at the point *B*. The track *d* is too short to allow us to establish its direction of motion by observations on the distribution of grains in the track. The secondary disintegration, *B*, can be explained in conventional terms if the emitted particle is a deuteron or a triton. We cannot assume that the particle *d* is emitted from *B* and leads to the disintegration *A*, unless *d* is a particle of charge $> 2e$ and with an energy greater than we have hitherto encountered

Observer: Miss P. Dyer Exposure: Chacaltaya

chance juxtaposition of the tracks of unrelated particles.

In addition to such fortuitous events, we have now found many examples of secondary effects produced by particles emitted during nuclear explosions. These include the elastic collisions of protons, deuterons and tritons with the nuclei of hydrogen and other elements present in the emulsion. In other instances, of which Fig. 2 shows an example, we have observed fast particles, emitted from 'stars', which produce disintegrations by collisions with nuclei. The particle producing the track *d* in Fig. 2, which led to the secondary disintegration *B*, cannot have been a proton; for its velocity, as indicated by the 'grain-density' in the track, is too low. The disintegration can, however, be explained in conventional terms, if the particle producing track *d* is assumed to have been a deuteron, or one of greater mass.

In a previous paper, examples were given of disintegrations produced at the end of their range by mesons observed to be ejected during the explosive disintegration of nuclei. Two further events of this type are shown in Figs. 3 and 4. In these photographs, the characteristics of the tracks of the particles producing the secondary disintegrations, *S*, make it certain that they are produced by mesons. In both cases, protons are emitted from one or other of the disintegrations which reach the end of their range in the emulsion. Their tracks can therefore be compared with those of the associated mesons, in conditions which are unaffected by 'fading'.

In conformity with our classification, we refer to such particles as 'ejected σ-mesons'. In other similar events, such as those represented in Figs. 5 and 6, the ejected particles producing the secondary disintegrations are of short range, but the tracks show changes in direction due to scattering, so that we can identify the corresponding particles as mesons with confidence.

While the ejected mesons are commonly observed to be created in processes which lead to the disintegration of the parent nucleus with the emission of several charged particles, the event represented in Fig. 7 has different characteristics. The meson originates in an interaction which leads to the emission of a single heavy charged fragment of short range. In no case have we observed the origin of the

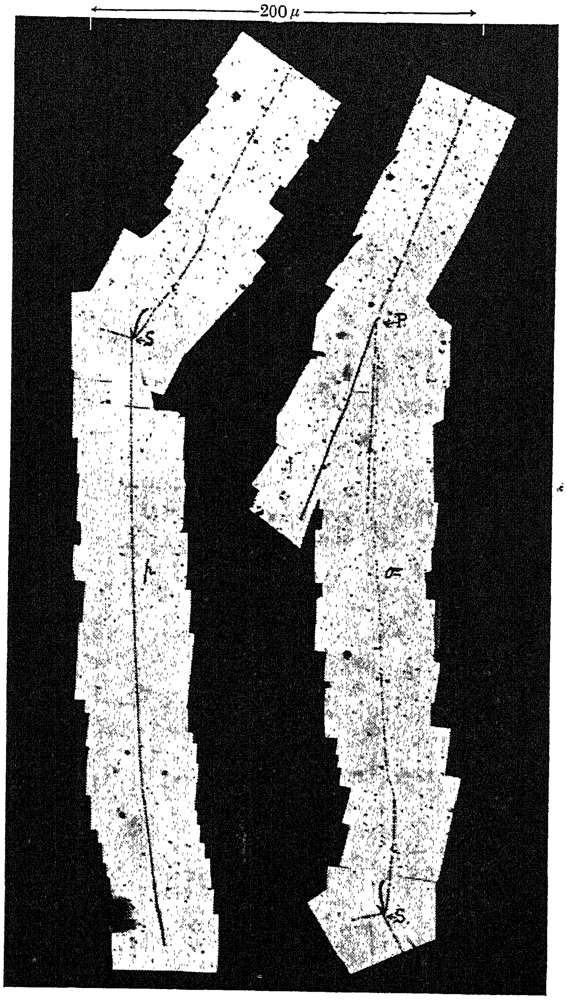

Fig. 3. Ejected σ-meson

A meson, σ, created during the explosive disintegration of a nucleus at the point *P*, reaches the end of its range and produces the secondary disintegration at *S*. Four particles are emitted during the secondary disintegration, one of which is a proton, *p*, of nearly the same range as the meson. The mosaic has been arranged to facilitate a comparison of the characteristics of the two tracks

Observer: Mrs. W. J. Van der Merwe Exposure: Jungfraujoch

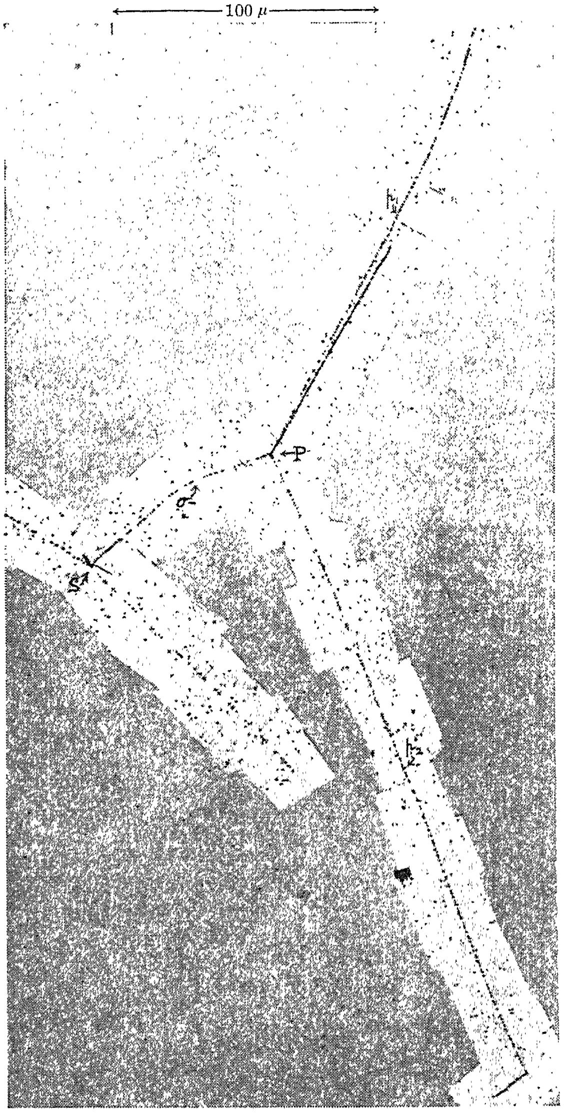

Fig. 4. Ejected σ-meson

Observation in a plate exposed at sea-level. The tracks are faded, and the event probably took place more than a month before the development of the plate. We interpret the event as due to the emission of a meson, σ, from the star *P*. The meson reaches the end of its range and produces a disintegration with the emission of three particles, of which we can distinguish the tracks. We attribute p_1 and p_2 to protons, which came to rest in the emulsion and of which the tracks can be compared with that of the meson
Observer: P. H. Fowler Exposure: Bristol (200 ft.)

track of a meson in the emulsion, unaccompanied by the emission of one or more heavy charged particles. In one or two cases where such an event is suggested by a casual inspection, closer observation shows that the meson has entered the emulsion at a large angle of 'dip', and has been scattered through a large angle, afterwards moving in a plane nearly parallel to the surface of the emulsion. As a result, the track becomes suddenly more clearly visible after the point of scattering.

Figs. 3–7 are characteristic of seventeen events which we attribute to the ejection of σ-mesons. In addition, we have found three examples of ejected mesons which stop in the emulsion without producing an observed nuclear disintegration. In determining the frequency of occurrence of these ejected ρ-mesons, we meet the following difficulty. We have now observed more than 10,000 'stars' each of which is accompanied by the emission, on the average, of several protons. Among such a large number, we must expect to find some protons which suffer abnormally large deflexions in passing through the emulsion, and which might therefore be wrongly identified as mesons. On the other hand, by over-emphasizing the frequency of occurrence of such abnormally scattered protons, we may reject tracks which were, in fact, produced by mesons. The difficulty is serious only when the particles are of short range, so that the additional evidence provided by observations on the change of grain-density along the track is meagre. Because of these difficulties, we cannot be certain that, apart from statistical fluctuations, the relative numbers of ejected ρ- and σ-mesons are accurately represented by the present observations. We can say with confidence, however, that the number of ejected σ-mesons greatly exceeds that of the corresponding ρ-mesons.

Disintegrations Produced by Ejected σ-Mesons

We have now observed the tracks of more than 5,000 slow ρ-mesons and 600 σ-mesons, which originate outside our emulsions. It is reasonable to assume that approximately half the ρ-mesons have a negative charge. Assuming that the true proportion is 40 per cent, a figure which is consistent with recent measurements of the charge and the mass of cosmic ray mesons by magnetic deflexion experiments[3], we can determine the relative frequency with which negative mesons of all types,

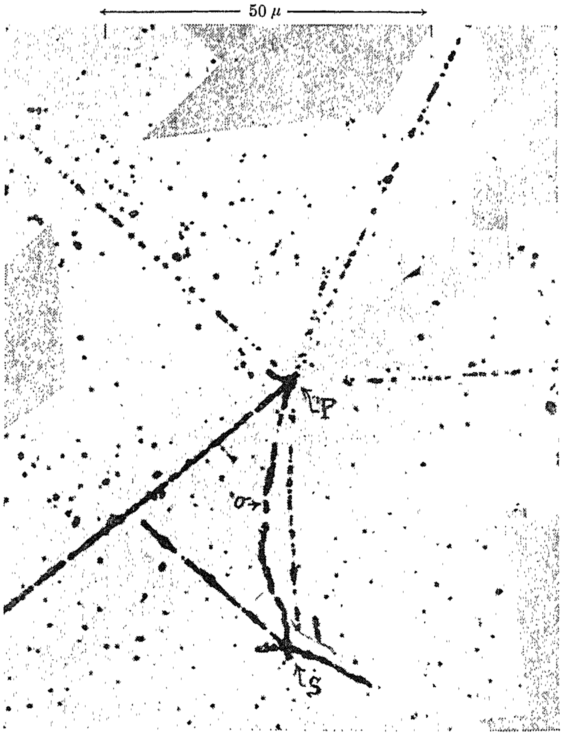

Fig. 5. Ejected σ-meson

The meson originates in the star *P*, and produces the disintegration *S* from which four charged particles are emitted. The track of the meson has a large angle of 'dip' in the emulsion, and the apparent 'grain-density' is increased through foreshortening
Observer: Mrs. G. Cohen Exposure: Kilimanjaro

at the end of their range in our emulsions, lead to the production of different numbers of heavy charged particles of which we distinguish the tracks. The result is shown in Fig. 8*a*.

We can also determine the corresponding distribution for those slow mesons which originate in nuclear explosions in the emulsion; see Fig. 8*b*. In spite of the uncertainty in the true numbers of ejected ρ-mesons—which lead to no secondary particles of which we distinguish the tracks—and the relatively small total number of ejected mesons observed hitherto, it is clear from Fig. 8 that there are substantial differences between the two distributions. In particular, a much greater proportion of the ejected mesons lead to disintegrations with the emission of heavy particles than is the case with negative mesons which come to the end of their range in the emulsions after being generated at points outside it. Thus, suppose the ejected mesons to be identical in type with the ordinary negative mesons. From the distribution shown in Fig. 8*a*, it can be shown that for every negative meson which produces a disintegration with the emission of one or more heavy charged particles, there are four which give rise to no observed secondary particles. We should therefore expect the observed seventeen 'ejected' σ-mesons to be accompanied by about seventy cases in which an ejected meson produces no observed disintegration at the end of its range in the emulsion. This number is to be compared with the three actually found. We must conclude that the ejected mesons are of a different nature from the majority of the negative mesons which enter the emulsion from points outside it. A similar result follows if the fraction of the ρ-mesons which are assumed to be negatively charged is reduced to 20 per cent or lower.

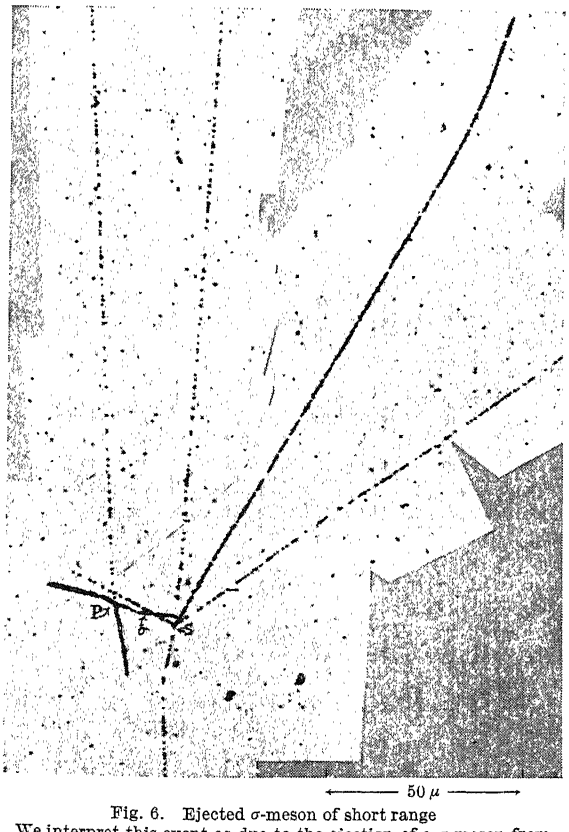

Fig. 6. Ejected σ-meson of short range

We interpret this event as due to the ejection of a σ-meson from the point *P*, the particle producing a secondary disintegration at the point *S*. The scattering of the particle producing the track is clearly marked, but its direction of motion is ambiguous. Our interpretation is based on the large deviation of the track near *S*, a feature commonly observed with mesons at the extreme end of their range

Observer: Mrs. W. J. Van der Merwe Exposure: Jungfraujoch

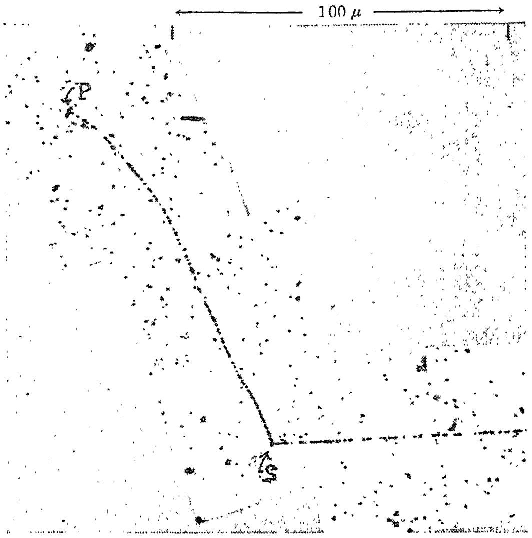

Fig. 7. In this event, a meson is produced at the point *P*, and at the end of its range it produces a disintegration at the point *S* from which a single proton is emitted. In contrast with the other events, the production of the meson appears to be accompanied by the emission of a single heavy particle of short range

Observer: Mrs. B. A. Moore Exposure: Jungfraujoch

The results also appear to have a bearing on the important question of the atomic capture of mesons by atoms. A large proportion of the ejected mesons observed in the present experiments must have been brought to rest in the gelatine, and have produced the disintegration of a light nucleus. In a subsequent paragraph we suggest that the ejected mesons are heavy particles (300 m_e) with a short life-time, $\tau \sim 10^{-8}$ sec. If this is correct, the time which elapses before they are captured into a *K*-orbit must be less than this value. A similar result follows, presumably, for mesons of mass $\sim 200\, m_e$. The present results, therefore, give strong support for the view that the delayed coincidence experiments cannot be explained as due to the time taken by a negative meson to reach a *K*-orbit[4,5].

Absence of Ejected π-Mesons

A second striking feature of the observations is the absence of any ejected π-mesons, particles which recent experiments by Gardner and Lattes[6] prove to be positively charged. We cannot be certain that all the ejected mesons we have found are negatively charged, for some of the three ejected ρ-mesons might be assumed to be positive. We can be sure, however, that most of the ejected mesons, and it is reasonable to assume that all of them, are negative.

We can account for the failure to observe a positively charged ejected meson, in the conditions of our experiments, in terms of the repulsive forces exerted on such a particle during its escape from the parent nucleus; forces which will ensure that it will be emitted with an appreciable kinetic energy. Because of the rapid increase of range with energy, an increase in speed of emission of a particle will greatly decrease the probability of its coming to rest in the emulsion and being identified. It is therefore

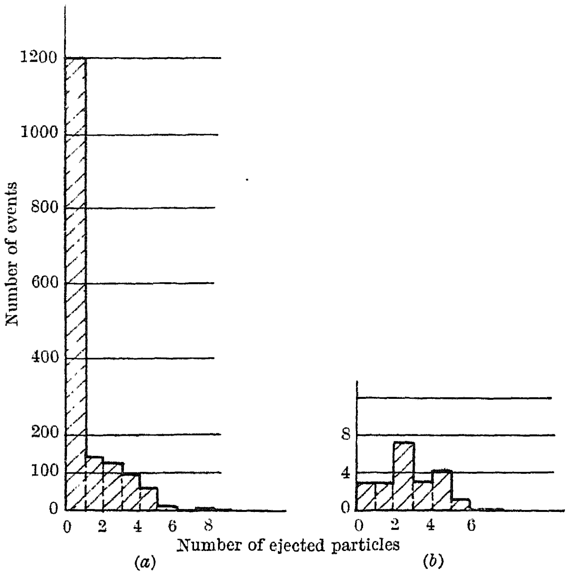

Fig. 8. Relative frequency of the disintegrations produced by negative mesons which lead to the emission of different numbers of heavy charged particles; (a) mesons entering the emulsion; (b) mesons created in the emulsion

reasonable to attribute the marked inequality between the observed numbers of ejected positive and negative mesons to the particular conditions of our experiments, and the effect of the nuclear charge.

Interpretation of the Results

In accord with previous assumptions, it is possible to give an account of the present observations in terms of two types of mesons, of mass $\sim 320\, m_e$ and $\sim 200\, m_e$, which can be charged either positively or negatively. We assume that the heavy particles have a strong interaction with nucleons, and that they are produced in processes which commonly lead to the explosive disintegration of nuclei. A heavy meson is regarded as having a short life-time, so that when it is produced in the atmosphere, it usually decays in flight to produce a light meson and a neutral particle. Further, from measurements of the masses[9], it is reasonable to assume tentatively that these light particles are identical with the mesons of the penetrating component of the cosmic rays. It then follows, from the delayed coincidence experiments[7], that the negative particles of this type which are brought to rest in the gelatine will decay with the emission of an electron, and will appear in the present experiments among the ρ-mesons. On the other hand, some of the light negative mesons which stop in a silver bromide grain may produce disintegrations with the emission of heavy particles, and so appear among our σ-mesons; otherwise they will contribute to the ρ-mesons.

These assumptions allow us to explain the difference in the two distributions, shown in Fig. 8; for an ejected σ-meson is to be regarded as a heavy meson which, at the end of its range in solid materials, is captured by an atom, afterwards interacting with the nucleus, whatever its atomic number, and leading to its disintegration. On the other hand, the majority of the negative mesons entering the emulsion are regarded as light mesons, which, if captured by an atom of low atomic number, decay with the emission of an electron[7]; and which, even if captured by one of high atomic number, may give rise to no observed secondary heavy particles.

It may be noticed that the observation that a few of the ejected mesons do not produce disintegrations with the emission of heavy charged particles is not inconsistent with the view that they are all of mass $\sim 320\, m_e$; for, in some cases, one or more neutrons may alone be emitted in the disintegrations they produce. On the other hand, we cannot exclude the possibility that some of the ejected particles are light negative mesons. The evidence strongly suggests, however, that the proportion of light particles, of the type commonly found among the penetrating particles of the cosmic radiation, which are produced directly in the observed processes, is less than 20 per cent.

The origin of the different types of mesons in the cosmic radiation, according to the present assumptions, is shown schematically in Fig. 9. It is assumed that the 'primary radiation', possibly neutrons and protons, in collisions with nuclei, gives rise to the emission of both positive and negative particles of mass $\sim 300\, m_e$, π^+ and π^-. When formed in the high atmosphere, these particles decay in flight to produce particles, μ^+ and μ^-, of mass $\sim 200\, m_e$, and a neutral particle ν^0. The indicated decay of this neutral particle into two photons is speculative. Those of the μ-particles formed by decay in flight can stop in the emulsion either in the gelatine ○, or in a silver bromide grain ▨. The positive particles, μ^+, are assumed to decay with the emission of an electron and a neutral particle, both of which are unobserved in the emulsion. It is further assumed that the μ^--particles, when stopped in gelatine, also decay with the emission of a negative electron. These particles, μ^+ and μ^-, together constitute the majority of the ρ-mesons. Some of the μ^--particles which stop in a silver bromide grain may possibly produce disintegrations with the emission of heavy particles. In this case they will appear in our experiments among the σ-mesons.

When the primary radiation interacts with the nuclei of matter in the immediate neighbourhood of the plate, the π^+- and π^--particles, if ejected with a suitable kinetic energy, can stop in the emulsion. The π^--particles then interact with either light or heavy nuclei to produce nuclear disintegrations; they thus contribute at least the majority of the σ-mesons. The π^+-particles come to the end of their range and suffer μ-decay; they thus appear as our π-mesons. Finally, if the collision of the primary radiation with a nucleus occurs in the emulsion, we sometimes observe the ejection of a π^--particle. In accord with the present assumptions, we also postulate that π^+-particles are sometimes emitted in such explosions, but that they commonly escape detection because of their higher energy of emission.

In accordance with the relationships suggested in this scheme, we should expect to observe approximately equal numbers of σ- and π-mesons. Recent experiments have enabled us to increase the accuracy of the determination of the relative frequency of occurrence of the two types, and we have obtained the value $N\sigma/N\pi = 1{\cdot}05 \pm 0{\cdot}25$.

In spite of the qualitative agreement between the new experimental results and the present assumptions, it is clear that the latter must be accepted, at present, with reserve. Prof. Klein[8] has raised the question, for example, as to whether the heavy negative mesons, which produce disintegrations and which are produced artificially, are, in fact, the negative counterparts of the positively charged

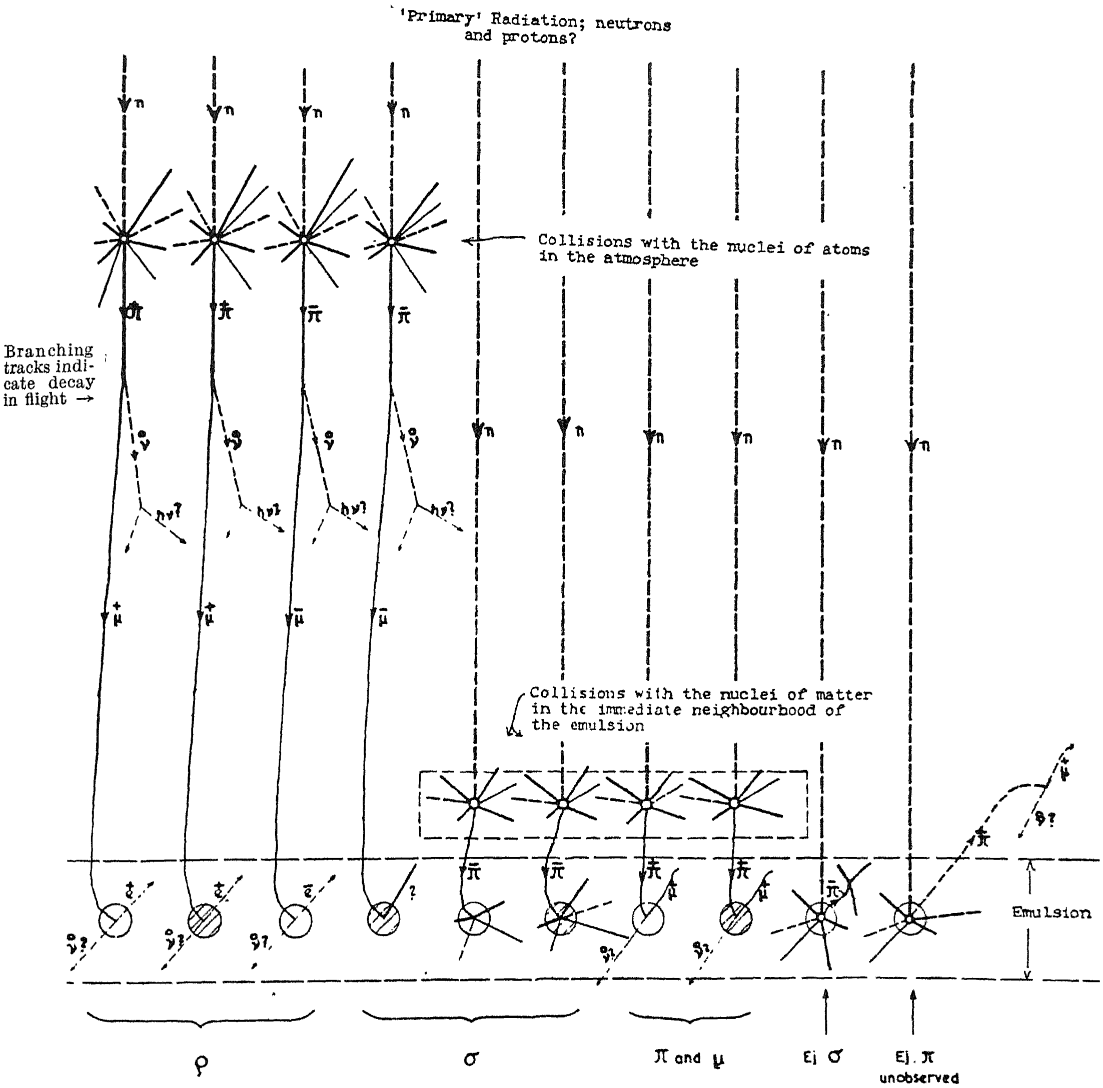
'Primary' Radiation; neutrons and protons?
n
Collisions with the nuclei of atoms in the atmosphere
π
Branching tracks indicate decay in flight →
ν
hν?
μ
Collisions with the nuclei of matter in the immediate neighbourhood of the emulsion
Emulsion
ρ
σ
π and μ
Ej σ
Ej. π unobserved

Fig. 9. Tentative schematic representation of processes giving rise to the different classes of mesons, ρ-, σ-, π- and μ-mesons, observed in photographic emulsions

π-mesons. While the approximate equality in the numbers of σ- and π-mesons observed in the cosmic radiation, and the determinations of their masses, give strong support to the assumption that they are particles of the same type, it cannot be regarded as finally established. Secondly, the limits of error in the determination of the masses of the individual cosmic-ray mesons are such that we cannot yet exclude the possibility that most of the ρ-mesons are a mixture of different types, of different mass. Both these points of uncertainty will presumably be clarified when more accurate determinations of the mass of the different classes of particles have been made.

In view of the above reservations, and of the possibility that the ejected σ-mesons are composed of particles of different types, we may summarize the results of the present experiments in the following general terms. The mesons which we observe to be produced also have a high probability, when reduced to low velocities, of producing nuclear disintegrations of both light and heavy elements, with the emission of heavy particles. Their behaviour is therefore consistent, in both respects, with the view that they have a strong interaction with nucleons.

We are indebted to Dr. Franzinetti and Dr. S. Rosenblum for some preliminary information on the sign of the charge of ρ-mesons obtained in magnetic deflexion experiments; to Dr. H. Fröhlich and Mr. P. H. Fowler for discussions on the relative numbers of ejected σ- and π-mesons; and to Mr. A. G. Meek for organising a safari for the ascents of Kilimanjaro to obtain the exposures at 16,000 ft.

[1] Marshak and Bethe, *Phys. Rev.*, **72**, 506 (1947).
[2] Lattes, Muirhead, Occhialini and Powell, *Nature*, **159**, 694 (1947). Lattes, Occhialini and Powell, *Nature*, **160**, 453 and 486 (1947).
[3] Powell and Rosenblum, *Nature*, **161**, 473 (1948).
[4] Fermi, Teller and Weisskopf, *Phys. Rev.*, **71**, 314 (1947).
[5] Fröhlich, *Nature*, **160**, 255 (1947).
[6] Gardner and Lattes, *Science*, March 12, 1948.
[7] Conversi, Pancini and Piccioni, *Phys. Rev.*, **71**, 209 (1947). Anderson, Adams, Lloyd and Rau, *Phys. Rev.*, **72**, 724 (1947).
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NEWS and VIEWS

Hope Professorship of Zoology at Oxford : Prof. G. D. Hale Carpenter, M.B.E.

THE best wishes of scientific men everywhere go to Prof. G. D. Hale Carpenter on the occasion of his retirement from the Hope professorship of zoology at Oxford. He has occupied this chair since 1933 when he succeeded the late Sir Edward Poulton. After taking his degree in the honours school of natural science at Oxford, Prof. Carpenter gained a scholarship at St. George's Hospital Medical School, London. There he completed the usual medical courses, and obtained the certificate with distinction of the London School of Tropical Medicine. Thus qualified, he joined the Colonial Medical Service in 1910 and was appointed in the same year to the Royal Society's Sleeping Sickness Commission in Uganda. In the First World War he served in the East African Campaign during the years 1914–18. Afterwards he was made specialist officer for the control of sleeping sickness in Uganda from 1920 until 1930 and, in the following year, he retired from the Colonial Service.

Settling in Oxford amid highly congenial surroundings, Prof. Carpenter identified himself with the aims of the Hope Department, and it must have been a source of gratification to him when he followed in the footsteps of the great protagonist of Darwinism only two years later. All through his African career he was an ardent field naturalist. His duties in connexion with tsetse-fly problems took him constantly into the field. Many of his experiences and observations are embodied in his two books "A Naturalist on Lake Victoria" (1920) and "A Naturalist in East Africa" (1925). While at Oxford he has established a teaching course in entomology and published in collaboration with E. B. Ford a handbook on "Mimicry" in Methuen's Biological Series. This latter book embodies much of Carpenter's original work and notably his field observations on mimetic Lepidoptera and their enemies. In this way he has replied to the many critics of the mimicry theory who, as often as not, had no such first-hand information with which to support their contentions. During his tenure of the Hope professorship, in addition to his writings on Lepidoptera, he has developed the scientific value of the associated collections along sound lines. In particular, predaceous insects and their prey and the evidence of bird attacks on Lepidoptera deserve special mention. Prof. Carpenter has served as president of the Royal Entomological Society of London (1945–46), and as a vice-president of the Linnean Society.

Dr. G. C. Varley

DR. G. C. VARLEY, who has been appointed to the Hope professorship of zoology at Oxford, was educated at Manchester Grammar School and went up to Cambridge with a major open scholarship in natural science at Sidney Sussex College in 1929. He obtained a first class in both parts of the Natural Sciences Tripos and was awarded the Frank Smart Prize for zoology in 1933. In the same year he was appointed to a research studentship at Sidney Sussex College and became superintendent of the Entomological Field Station. During 1935–38 he was a research fellow of his College and in the latter year he obtained the degree of Ph.D. for a thesis on "The Natural Control of the Knap-weed Gallfly". In 1938 he was appointed to a University demonstratorship and became curator of insects in the University Museum of Zoology at Cambridge. During the early part of the War, he was engaged in research on wireworm control, and in 1941 he joined the Army Operational Research Group of the Ministry of Supply. Here he did distinguished work on the application of radar to coast defence and was promoted to the rank of senior experimental officer. After the end of the War, in 1945, he was appointed to the readership in entomology in the Department of Zoology at King's College, Newcastle-on-Tyne. Dr. Varley's main interests lie in the field of population studies with particular reference to insects, and he has a wide knowledge of the whole field of ecology. He is a first-class naturalist and a man who has exceptional powers for interesting his students in all branches of his subject. His new appointment will give him the opportunity of developing to the full his chosen field of work at a university which has already made such important contributions to the study of animal ecology.

Paris Academy of Sciences : Prof. Robert Courrier

THE Paris Academy of Sciences has two 'secrétaires perpétuels' : Prince Louis de Broglie, and very recently, Prof. Robert Courrier, who was elected in May in succession to the late Prof. Alfred Lacroix. Prof. Courrier, who was born in 1895, began his medical studies at Nancy, but they were interrupted by the First World War. On demobilization in 1919, he went to Strasbourg to work in the laboratory of the well-known endocrinologist, Prof. P. Bouin. He was appointed a professor in the Faculty of Medicine at Algiers in 1926, and went to Paris in 1938, where he has since held a chair in the Collège de France. He was elected to the Academy of Medicine in 1941, and to the Academy of Sciences in 1944.

Prof. Courrier's work has been on the glands of internal secretion. One of his first investigations concerned the thyroid, when he showed that one can inhibit this gland by massive doses of the thyroid hormone. He produced important evidence in support of the theory of Prof. Bouin, on the elaboration of the male hormone by the interstitial tissue of the testicle. He played a large part in the early researches on the female sex hormones ; he found in the human female the follicular hormone which Allen and Doisy had just discovered in the sow ; he found this hormone outside the ovary, and in particular in the amniotic liquid, and he remarked that it could pass through the placenta and the mammary gland, and powerfully affect the fœtus and the newly born. He demonstrated the hormonal dualism of the ovary, at a time when leading workers held the view that only one hormone was secreted. With his pupils he has studied for a long time the functional relations connecting the two ovarian hormones, and he has made a detailed analysis of the endocrinology of gestation, which he has described in a recently published book.

Mathematics at University College, Bangor: Mr. D. E. Littlewood

MR. D. E. LITTLEWOOD, whose appointment to the chair of mathematics at the University College of North Wales, Bangor, in succession to Prof. T. G. Cowling, has recently been announced, is well known as an algebraist. His best-known work is concerned with the theory of group characters, a branch of algebra which has been extensively developed in the last fifty years and which has an unusually wide application to fields as diverse as the algebraic theory of invariants and modern quantum mechanics. Littlewood's work is in the direct line of tradition associated with the names of Frobenius, Alfred Young, and Schur; and his book, "The Theory of Group Characters" published in 1940, is a standard work on the subject. In recent papers, Littlewood has developed a calculus of a class of symmetric functions known as Schur functions which have recently been shown to have extensive applications in invariant theory.

Promethium, the New Name for Element 61

At a symposium held by the American Chemical Society at Syracuse University on June 30, J. A. Marinsky and L. E. Glendenin, who during the War had succeeded in separating element 61 from the other uranium fission products, proposed to christen this element 'promethium'. They explained their choice by a reference to Prometheus, "who stole fire from heaven for the use of mankind and for his audacity was chained to a mountain by the gods and set upon by vultures. This name not only symbolizes the dramatic way in which the element may be produced in quantity as a result of man's harnessing of the energy of nuclear fission, but also warns man of the impending danger of punishment by the vulture of war." In a review published some eighteen months ago (*Nature*, **159**, 8; 1947) the conclusion was reached that Prof. C. D. Coryell's group, to which Marinsky and Glendenin belong, had the strongest claim to the discovery of element 61 and was entitled to give it a name. Some may perhaps think the present proposal a little far-fetched, since there are more impressive effects of atomic energy known than the production of small quantities of a new rare earth, and classical students may take exception to the vultures—since Prometheus' quarrel was with Zeus, the bird sent by his antagonist to torture him was, naturally, an eagle; but the etymology of this new name will soon be of as little importance as that of dozens of other element names which are much less appropriate. There are still the rival claims for 'illinium' and, more recently, for 'cyclonium' (see *Chemical and Engineering News*, **25**, 2555; 1947), and it is, therefore, too early to say whether the chemists of Coryell's group will be generally recognized as the discoverers of element 61; but their brilliant work seems to merit this international recognition, and there is a great likelihood that promethium (symbol Pm) will take its permanent place in the table of the chemical elements.

Commonwealth Plant Breeders' Meeting

An informal meeting of Commonwealth plant breeders was held at the School of Agriculture, Cambridge, during June 24–25. Representatives from Australia, Canada, England, Malaya, New Zealand, Northern Ireland, Scotland, Sierra Leone, South Africa, Sudan, Tanganyika and Wales were present; Dr. P. S. Hudson, director of the Commonwealth Bureau of Plant Breeding and Genetics, acted as chairman. The proceedings of the meeting included a review by Dr. P. S. Hudson and Mr. R. H. Richens of the work of the Commonwealth Bureau of Plant Breeding and Genetics since the last similar meeting, short reports by the delegates of the principal lines along which plant breeding is developing in the various Commonwealth countries, and an account by Dr. P. S. Hudson of the results of the meeting held at Washington last April, between the Food and Agriculture Organisation, the Commonwealth Agricultural Bureaux, the U.S. Department of Agriculture and other bodies, on genetic stocks. Among the resolutions passed at the meeting, several deprecated any reduction in the number or length of the abstracts appearing in *Plant Breeding Abstracts*, the periodical published by the Commonwealth Bureau of Plant Breeding and Genetics; support was given to a proposal to institute a standing inquiry service whereby plant breeders should be sent details at regular intervals of all published articles bearing on their own field of research; and suggestions were made to provide for an efficient service for the maintenance of genetic stocks of crop plants. The proceedings of the meeting will be circulated to the delegates and to other interested bodies.

Olympic Torches

The Organising Committee of the XIVth Olympiad approached the Department of Scientific and Industrial Research in 1946 for assistance and advice on the design of a torch to be carried by relays of runners across Europe from the plain of Olympia to Wembley Stadium in London, and on the most suitable fuel. This problem was undertaken by the Fuel Research Station, and the actual investigation was carried out by Dr. L. R. B. Shackleton. After many trials, it was decided that the most suitable fuel was hexamine in the form of tablets. Hexamine gives a non-luminous flame, and to make the flame visible in all weathers 6 per cent of naphthalene was added. The fuel was manufactured by Promedico Products, Ltd., 22, Turle Road, London, N.4. Prototype torches made at the Fuel Research Station were tried out by runners, first from the South London Harriers and, after certain modifications in design, by officers from the Royal Naval College, Greenwich. In the final design of the torch, seven tablets are enclosed in a perforated metal cylinder with an inner sleeve concealing the lower three tablets. As the upper tablets burn away, the lower reserves are forced up into the burning zone by a spring. In order to facilitate lighting, the Wessex Aircraft Engineering Co., Ltd., Salisbury, provided a tablet of nitrate composition which was introduced on top of the fuel pack. A quick-match, provided for ignition, protruded through the perforated container. One or two final refinements were introduced at the concluding stages to safeguard the effectiveness of the torches during transport to the various countries through which the relay runners had to pass. The fuel tablets were totally enclosed in a nitro-cellulose cover provided by Cascelloid, Ltd., High Holborn, London. This cover burned immediately on ignition, leaving no carbon residue. The perforated metal fuel container was also capped and sealed with adhesive tape. Both of these precautions were considered necessary to preserve the fuel and to avoid any risks of accidental ignition.

Museum of the History of Science, Oxford

Since 1940 the Museum of the History of Science, Oxford, has been making inquiries as to the whereabouts of a number of valuable and irreplaceable objects which had been stored at the beginning of the War by the late curator of the Museum, Dr. R. T. Gunther. These included the oldest dated instrument in the world, an astrolabe dated A.D. 984, the astrolabes of Queen Elizabeth and Archbishop Laud, the sundial made by Nicolaus Kratzer for Cardinal Wolsey, and many other treasures. Dr. Gunther died without revealing the place where he had stored these valuables. They have now been found in the stone-vaulted basement of the Museum, packed in three cases which were labelled as containing various astronomical instruments of the late eighteenth century and mixed with a number of cases actually containing such instruments. By this means, it is conjectured, Dr. Gunther had intended not only to protect them from air attack but also from the searches of a possible invader. It is hoped that the Museum will open next October, when these treasures will be displayed once more to public view.

Use of Selenium for Pest Control

INVESTIGATIONS have shown that selenium salts, among other substances applied to the soil, are taken up by plants and will make the plants so treated poisonous to certain pests that attack them. Selenium compounds, such as sodium selenate, have lately been tried by a few growers for the control of chrysanthemum eelworm and some other pests of flower crops. This is dangerous because selenium compounds are poisons to man; moreover, they may persist for long periods in the soil, and if food crops are grown later in treated soil the plants may take up the poison in sufficient amount to make them injurious to health if eaten. For the present, neither sodium selenate nor any selenium compound should in any circumstances be used for pest control purposes. The Ministry of Agriculture and Fisheries understands that no proprietary insecticide containing selenium is manufactured in Great Britain.

Astronomical Instruments

SIR HOWARD GRUBB, PARSONS AND Co. have issued a catalogue of some of the astronomical equipment designed and manufactured by the Company. The photographs and illustrations are arranged in sections as follows: reflectors, refractors, domes, driving mechanism, breechpieces, transits, coelostats, objectives and mirrors, and also "In the Workshops". The illustrations do not represent in every detail the latest design practice because advances in engineering technique during the War are now applicable in some cases to the design of astronomical equipment. At the end of the book there is a list of the large telescopes—twelve altogether—manufactured by the Company between 1927 and 1947.

The Night Sky in August

NEW moon occurs on Aug. 5d. 04h. 13m., U.T., and full moon on Aug. 19d. 17h. 32m. The following conjunctions with the moon take place: Aug. 2d. 07h., Venus 9° S.; Aug. 9d. 05h., Mars 2° S.; Aug. 14d. 04h., Jupiter 4° N.; Aug. 31d. 03h., Venus 8° S. Mercury, which rises an hour before the sun on Aug. 1, is in superior conjunction on Aug. 11, and is badly placed for observation during the greater portion of the month. Venus rises at 1h. 40m., 1h. 20m. and 1h. 15m. at the beginning, middle and end of the month, respectively, and can be seen for some hours before sunrise. The stellar magnitude of the planet is about $-4\cdot2$ throughout August, and the visible portion of the illuminated disk varies from 0·3 to 0·47. Mars sets at 21h. 38m., 20h. 55m. and 20h. 10m. at the beginning, middle and end of the month, respectively, and can be seen for a short time after sunset. Jupiter, in the constellation of Ophiuchus, can be seen low in the evening, setting at 0h. 25m. and 22h. 30m. on Aug. 1 and 31, respectively. The planet is stationary on Aug. 16. Saturn, in conjunction with the sun on Aug. 19, is not well placed for observation. On Aug. 31 the planet rises an hour before the sun but is practically unobservable. No occultations of stars brighter than mag. 6 occur during August. The Perseid meteors attain a maximum about Aug. 10–12, but moonlight will partly interfere with the observation of the shower at that time.

Announcements

WE regret to announce the death of Sir Clifford Paterson, O.B.E., F.R.S., director of the Research Laboratories of the General Electric Co., Ltd., which occurred on July 26.

PROF. RAOUL COMBES, professor of plant biology in the University of Paris, has been elected to the Section of Botany of the Paris Academy of Sciences, in succession to the late Prof. P. A. Dangeard.

IN commemoration of the centenary of the birth of Baron Roland von Eötvös (see *Nature*, July 24, p. 135), a small collection illustrating his work has been arranged at the Science Museum, London. It will remain on view until September.

THE Managers of the Royal Institution have appointed Dr. D. P. Riley, University demonstrator in the Department of Mineralogy and Petrology, Cambridge, to the Dewar Research Fellowship, tenable in the Davy Faraday Laboratory of the Royal Institution. Dr. Riley will undertake a programme of research on the application of methods of X-ray diffraction analysis to the study of the structure of colloidal systems and biological material.

PART of the exhibition of photographs demonstrating the value of air photography to archæology recently held in London (*Nature*, July 17, p. 96) has been transferred to the Ashmolean Museum, Oxford, for the period August 2–September 4.

A SYMPOSIUM on the "Chemistry, Metabolism and Biological Effects of Steroid Hormones" will be held in the University of Wisconsin, during September 6–8, under the auspices of the University of Wisconsin and the U.S. National Research Council Committee on Growth, acting for the American Cancer Society. Among the topics to be discussed are: clinical use of steroids in gynæcology; growth and fattening of animals; metabolism and excretion of steroids; relation of structure to function of steroids; lactation and reproduction in animals; clinical and experimental work on cancer; metabolism of convalescence; sex differentiation and steroids. The symposium will be open to the public. Further particulars can be obtained from Dr. Edgar S. Gordon, chairman Symposium Committee, University of Wisconsin.

THE Science Co-operation Office in Cairo of the United Nations Educational, Scientific and Cultural Organisation has compiled a very useful list of scientific papers published in the Middle East and received by the Office up to March 1, 1948. The papers are classified under mathematics, mechanics and physics, chemistry, geology and geophysics, botany, zoology, medical sciences, engineering, agriculture and psychology, and there are single entries under palæontology and biology. Most of the entries are under zoology, medical sciences, agriculture and psychology. A list of periodicals reviewed includes particulars of frequency, price and the name and address of the publisher, the periodicals being arranged by countries.

LETTERS TO THE EDITORS

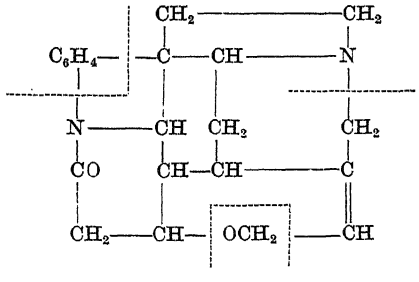
The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Synthesis of Vomipyrine

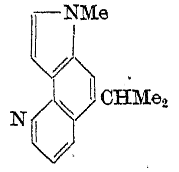
An outstanding result of Wieland's long series of investigations of vomicine was the degradation of the alkaloid to a base, $C_{15}H_{16}N_2$, termed vomipyrine[1]. This afforded yellow salts, and the spectrochemical behaviour clearly indicated its constitution as an alkylated pyrroquinoline, $C_{11}H_7N_2 . C_4H_9$, although the position of fusion of the rings and the position and distribution of the alkyl group or groups (2Et, Me, Pr, Bu, etc.) was unknown. Guesses based on the earlier strychnine formulæ were disproved by synthesis[2].

Even with the strychnine formula (I) now considered to be established beyond doubt[3] there remained some ambiguity. Our first idea was that vomipyrine should be 5-*iso*butyl-7 : 8-pyrroquinoline[4]; but a few months ago, Prof. H. Wieland kindly informed us that vomipyrine contained a methylimino-group. This modified our view and the base was then thought to be Ind-N-methyl-5-propyl-7 : 8-pyrroquinoline or Ind-N-methyl-5-*iso*propyl-7 : 8-pyrroquinoline (II). There was little evidence to enable a choice to be made between these, or, what is the same thing, to locate the carbon atom which is extruded from the skeleton.

However, a carbon atom had been lost once before, namely, in the distillation of the products of reduction of methylstrychninium salts. In this case the conclusion was reached that a carbon atom attached to oxygen had been eliminated[5]. Therefore, the constitution with an *iso*propyl group was favoured for vomipyrine.



I



II

The dotted lines in (I) indicate the fissions assumed to occur; the N-methyl group of (II) is not present in (I) but occurs in the related vomicine structure[6].

We therefore decided to synthesize a base of the constitution (II), and in the first place studied methods for the preparation of the hitherto unknown 7 : 8-pyrroquinoline itself. An application of the modified Skraup reaction[7] to 6-nitro-*o*-toluidine afforded 7-nitro-8-methylquinoline, m.p. 134–134·5°, and this, by reduction and formulation, was converted into 7-formamino-8-methylquinoline, m.p. 157°. Cyclo-dehydration to 7 : 8-pyrroquinoline, m.p. 216–217°, occurred on heating with potassium *t*-butoxide, although the yield was small. Treatment of this base with potassamide in liquid ammonia, followed by methyl iodide, yielded Ind-N-methyl-7 : 8-pyrroquinoline, m.p. 112°. The salts of the two tricyclic bases were yellow and the absorption spectra of the bases were like those of vomipyrine and other pyrroquinolines.

The way was thus open to an unambiguous synthesis of (II). *p*-Cymene was dinitrated[8] and reduced to 6-nitro-2-amino-*p*-cymene. The Bradford, Elliott and Rowe technique[7] was used in the preparation of 7-nitro-8-methyl-5-*iso*propylquinoline, m.p. 88°. This was reduced to the amine, m.p. 109°, which was formylated (m.p. 123°) and cyclo-dehydrated as above to 5-*iso*propyl-7 : 8-pyrroquinoline, m.p. 182–183° (hydrochloride, sinters at 222°, liquid at 226°; Wieland's base, $C_{14}H_{14}N_2$, obtained as a by-product in the formation of vomipyrine, was an oil; hydrochloride, sintered at 220°, m.p. 240°). The potassamide – liquid ammonia – methyl iodide method then gave the desired Ind-N-methyl-5-*iso*-propyl-7 : 8-pyrroquinoline (II), m.p. 108–108·5°. The base crystallized from light petroleum (b.p. 60–80°) in flat, rectangular, colourless plates, but two opposite angles were usually truncated, giving a six-sided outline. The ultra-violet absorption in methanol showed maxima at 2660 A. (log ε, 4·17) and 3380 A. (log ε, 3·75). There is a slight discrepancy here since Wieland and Horner[9] give for vomipyrine maxima at 2677 A. (log ε, 4·4) and 3347 A. (log ε, 3·8); the possible error indicated was, however, ± 20 A.

All doubt was dispelled when Prof. Wieland kindly furnished us with a small specimen of authentic vomipyrine. We are very grateful to him for this collaboration. This specimen crystallized from light petroleum in the characteristic six-sided plates and had m.p. 106·5–107·5° after drying at 50°/20 mm. Mixed with our synthetic base, the melting point was 108·5° after sintering at 107°.

Crystallographic, including X-ray, comparisons of the two specimens showed complete identity, and we are greatly obliged to Mrs. D. Hodgkin for kindly undertaking this work.

The bases fluoresced identically blue-violet in ethereal solution and gave identical (characteristic) Hopkins – Cole and pine-splinter reactions.

The importance of vomipyrine, always great, was enhanced by the recent demonstration of the relation of vomicine to strychnine[6]. It was then pointed out that vomicine chemistry had acquired a direct bearing on the strychnine problem. Although it is true that the constitution of strychnine is already established, the proof is a long one and, though rigid, it demands a close and critical study of a most complex branch of structural chemistry. The synthesis of vomipyrine facilitates a more direct approach. It confirms the constitution (I) in regard to those features that have been regarded by some authors as most open to criticism.

It is worthy of note that degradation products, which have been synthesized, cover the entire carbon and nitrogen skeleton and all the rings except that which includes the cyclic ether group. These products are dinitrostrychol, tryptamine, carbazole, vomipyrine and β-collidine. There is sufficient overlap to fix the positions of fusion of the rings.

R. Robinson
A. M. Stephen

Dyson Perrins Laboratory,
University, Oxford.
July 7.

[1] Wieland, H., and Horner, L., *Annalen*, **528**, 73 (1937).

[2] Horner, L., *Annalen*, **540**, 73 (1939); cf. ref. 9.

[3] Robinson, R., *Experientia*, **2**, 28 (1946). Openshaw, H. T., and Robinson, R., *Nature*, **157**, 438 (1946). Chakravarti, R. N., and Robinson, R., *Nature*, **160**, 18 (1947).

[4] Pausacker, K. H., and Robinson, R., *J. Chem. Soc.* (in the press, 1948).

[5] Perkin, W. H., Robinson, R., and Smith, J. C., *J. Chem. Soc.*, 1239 (1932).

[6] Bailey, A. S., and Robinson, R., *Nature*, **161**, 433 (1948).

[7] Bradford, L., Elliott, T. J., and Rowe, F. M., *J. Chem. Soc.*, 437 (1947).

[8] Kyker, G. C., and Bost, R. W., *J. Amer. Chem. Soc.*, **61**, 2469 (1939)

[9] Wieland, H., and Horner, L., *Annalen*, **536**, 89 (1938); cf. ref. 2.

Structure of Dunnione

The investigation of dunnione and its transformation products by Price and Robinson[1] did not completely establish the structures of these compounds. The work was interrupted by the War; but Dr. Price has recently suggested that the further examination of these substances be included in a programme of research on quinones which is proceeding in this Laboratory. As closely related work is being done in the United States, it seems desirable to give a brief preliminary report of the scope of the present investigations, and of the results already obtained.

The structures previously assigned to dunnione and the *iso*-dunniones have been confirmed by the synthesis of *dl*-dunnione and β-*iso*-dunnione. Claisen rearrangement of 2-γγ-dimethylallyloxy-1 : 4-naphthaquinone gives rise to two products: the normal rearrangement product, 2-hydroxy-3-αα-dimethylallyl-1 : 4-naphthaquinone (m.p. 70–71°), and the abnormal product, 2-hydroxy-3-αβ-dimethylallyl-1 : 4-naphthaquinone. The latter compound proved to be identical with the *iso*-dunniol of Price and Robinson (*loc. cit.*), and by ring closure with sulphuric acid it is converted to αββ-trimethyldihydrofurano-1 : 2-naphthaquinone identical with the β-*iso*-dunnione derived from natural dunnione. Similarly, ring closure of the normal rearrangement product gives ααβ-trimethyldihydrofurano-1 : 2-naphthaquinone (m.p. 93–94°), which is evidently the racemic modification of dunnione. Its melting point is not depressed by mixing with the natural dextrorotatory pigment (m.p. 98–99°), and on treatment with cold alkali it is gradually converted to two products, which are evidently *dl*-α-dunnione (m.p. 110–111°) and *dl*-*allo*-dunnione (m.p. 141–142°). The first of these gives β-*iso*-dunnione on heating with sulphuric acid, and the second shows the characteristic absorption spectrum previously recorded[2] for the dextrorotatory *allo*-dunnione derived from natural dunnione.

It is noteworthy that the normal Claisen rearrangement of the γγ-disubstituted allyl ether was accomplished simply by boiling an alcoholic solution under reflux for a few hours. The yield was 93 per cent. When the ether was heated for a few minutes, without solvent, at a temperature slightly above its melting point, the main product was that resulting from abnormal rearrangement.

The structure of β-*iso*-dunnione has also been proved by an independent synthesis starting from 2-hydroxy-3-βγγ-trimethylallyl-1 : 4-naphthaquinone (m.p. 169–170°).

With the structures of these compounds thus established, it seems evident that the change from the dunnione to the *iso*-dunnione structure is simply a somewhat unusual example of the Wagner–Meerwein type of rearrangement.

Furthermore, it seems probable that the rearrangement of dunnione to *allo*-dunnione involves a reaction characteristic of 2-hydroxynaphthaquinones having a tertiary alkyl group in the quinone ring. This hypothesis is supported by the observation that 2-hydroxy-3-αα-dimethylallyl-1 : 4-naphthaquinone undergoes a similar reaction when heated with aqueous alkali, giving a product (m.p. 148–149°) which dissolves in aqueous sodium bicarbonate to give a *yellow* solution. An analogous product is obtained by the action of alkali on 2-hydroxy-3-ααβ-trimethylallyl-1 : 4-naphthaquinone (m.p. 81–82°).

Full details of this work will be published elsewhere.

R. G. Cooke

Organic Chemistry Laboratory,
University of Melbourne.
April 2.

[1] Price and Robinson, *J. Chem. Soc.*, 1522 (1939); 1493 (1940).

[2] Cooke, Macbeth and Winzor, *J. Chem. Soc.*, 878 (1939).

A Natural Precursor of the Folic Acid Complex

Recently Elvehjem and his co-workers[1] have demonstrated the presence, in rat liver homogenates, of a natural precursor capable of conversion by enzymes also present in liver to material having folic acid activity. They base the use of the term 'folic acid' on the fact that there is no evidence that the material produced is identical with pteroylglutamic acid. The same considerations apply to its use in the present communication.

Following observations made some time ago[2] that similar activity can be produced chemically by the interaction of histidine with certain components of an acid hydrolysate of casein, I have indicated[3] that this amino-acid may also act as a biological precursor of some member of the folic acid complex, and it now appears that in all probability it is identical with the precursor described by Elvehjem.

An enzyme capable of converting histidine into material having growth-stimulatory activity for *Streptococcus fæcalis* R. has been shown to be widely distributed in Nature. It occurs in relatively high concentration in mouse skin tissue, mouse and cat liver, hog spleen and duodenum and in horse heart. Certain of these tissues contain preformed growth factor, as is shown by the fact that samples heated to destroy enzyme activity induce marked growth and acid production in cultures of *S. fæcalis* R. (cf. Table 1). Also apparently they contain appreciable amounts of the precursor postulated by Elvehjem, since incubation of fresh samples causes an increase in activity.

Table 1. The activity of cat liver extract in producing folic acid from histidine at *p*H 7·4, estimated in terms of ml. *N*/20 acid produced in 10 ml. cultures of *S. fæcalis* in 18 hr. after the addition of 1 ml. of the mixture

Mixture incubated for 18 hr.	Acid production (ml. *N*/20)
0·5 ml. liver + 5·5 ml. phosphate buffer	4·45
0·5 ml. liver (boiled) + 5·5 ml. phosphate buffer	4·10
0·5 ml. liver + 5·0 ml. phosphate buffer + 0·5 ml. 0·1 per cent histidine	5·45
0·5 ml. liver (boiled) + 5·0 ml. phosphate buffer (solution + 0·5 ml. 0·1 per cent histidine solution)	4·15

These preparations, in addition to the activity already present, are capable of producing increased activity when incubated in the presence of histidine. Table 2 shows the increased acid production in cultures of *S. fœcalis* induced by the addition of mouse skin extract after incubation with various quantities of histidine at *p*H 7·4 for 18 hr.

Table 2. Activity of 0·2 ml. mouse skin extract incubated for 18 hr. at 37° C. with histidine

Addition of histidine (μgm./ml.)	Acid production (ml. *N*/20)
150	3·31
75	3·32
37·5	2·91
18·0	2·47
0	1·45

As a preliminary to a separation of the active component of the enzyme complex present in an extract of cat liver, a preparation of vitamin B_c conjugase using this extract as source was made. When tested for folic acid production, it was shown that the fraction soluble in 50 per cent saturated ammonium sulphate solution which contained the conjugase was not adequate, but that the precipitate from this fractionation was also necessary for the reaction with histidine to take place.

The presence of relatively large amounts of folic acid in the liver preparations made separation and testing rather difficult, and the possibilities of horse heart were examined, since although it has only about one quarter the activity per mgm. dry weight, the preformed folic acid content is about one half that in the liver preparations. Partial purification has been effected by making use of the absorption of the protein on paper pulp in the presence of concentrations of ammonium sulphate which were insufficient to produce a precipitate. Treatment of this material with lower concentrations of ammonium sulphate elutes the activity quite effectively.

25 mgm. of dried horse heart (prepared at 40° C. by Viobin, Ltd.) was extracted with 200 ml. of *M*/15 phosphate buffer at *p*H 7·4. After filtration through a Seitz filter, the filtrate was diluted to 600 ml. with buffer one-third saturated with ammonium sulphate, and 50 gm. of paper pulp added. It was shaken for two hours and filtered. The paper was resuspended in 600 ml. of *p*H 7·4 buffer, 8·3 per cent saturated with ammonium sulphate, and reshaken. The paper after filtration was resuspended in 600 ml. water and treated as before. Table 3 records the activity of the various stages in this fractionation, showing that the majority of the enzyme is eluted by the dilute sulphate solution.

Table 3. Activity of fractions of a horse heart extract

Mixture incubated	Acid production ml. 0·5 *N* acid Actual	Increase due to histidine
0·1 ml. Original extract	0·12	
0·1 ml. Original extract + 500 μgm. histidine	0·46	0·34
0·3 ml. Paper filtrate	0·01	
0·3 ml. Paper filtrate + 500 μgm. histidine	0·08	0·07
0·3 ml. Paper $(NH_4)_2$ SO_4 eluate	0·14	
0·3 ml. Paper $(NH_4)_2$ SO_4 eluate + 500 μgm. histidine	0·50	0·36
0·3 ml. Paper water eluate	0·04	
0·3 ml. Paper water eluate + 500 μgm. histidine	0·08	0·04

In view of the fact that the enzyme system described above has been shown not to be identical with vitamin B_c conjugase, and the fact that Elvehjem has shown his enzyme to have a different *p*H optimum from the conjugase, it would appear likely that the two may be identical. The partially purified enzyme, after elution from the paper, has an optimum activity at *p*H 7·8, as opposed to the *p*H 7 optimum observed by Elvehjem. Such a drift, however, often occurs on purification. Assuming that the enzyme systems are identical, it would follow that the substrates are also related, if not identical. It has been shown that arginine and, to a certain degree, glutamic acid can replace histidine as substrate for the folic acid producing enzyme. Edlbacher[4] and Walker[5] have postulated the production of unstable intermediates in the oxidation of histidine in the liver. These intermediates, formamidino glutaric acid and formyl glutamine, bear a considerable structural similarity to arginine; and glutamic acid is the end point of the degradation. It may therefore be that the true substrates for the enzyme producing folic acid may be the unstable hexone bases produced during the oxidative deamination of histidine.

The implications of these observations are far-reaching in their effect on firmly held theories regarding the mammalian metabolism of the folic acid complex. If tissues of such a large variety of animals are capable of synthesizing folic acid *in vivo* as well as *in vitro*, doubt must be cast on theories attributing sulphonamide-induced blood dyscrasias to intestinal sterilization. Also it may be expected that the presence of amino-acids in biological materials will tend to produce discrepancies in microbiological assays of the growth factor.

A fuller account of these investigations will be given elsewhere.

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[1] Olson, O. E., Fager, E. E. C., Burris, R. H., and Elvehjem, C. A., *J. Biol. Chem.*, **174**, 319 (1948).

[2] Hall, D. A., *Biochem. J.*, **41**, 299 (1947).

[3] Hall, D. A., *Biochem. J.*, **42**, ix (1948).

[4] Edlbacher, S., and von Bidder, H., *Z. physiol. Chem.*, **273**, 163 (1943).

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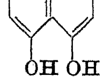
Hydrojuglone and Apparent Vitamin C in Walnuts

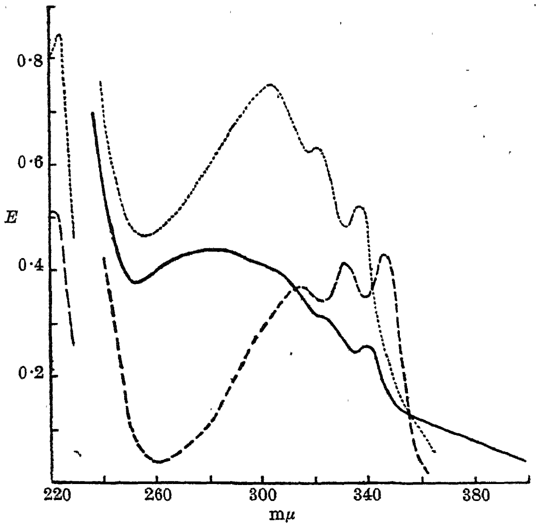
PREVIOUS communications from these laboratories[1–4] have shown that associated with the remarkably high concentrations of true vitamin C in different tissues of the walnut (*Juglans regia*) and allied species are considerable amounts of non-specific dye reductants provisionally termed[5] 'apparent vitamin C'. The proportion of apparent vitamin C in the total dye reductants varies from less than 5 per cent in the endocarp to more than 90 per cent in resting buds and catkins. We have now obtained evidence that this so-called apparent vitamin C in walnuts is mainly, if not entirely, a derivative of hydrojuglone or 1 : 4 : 5 trihydroxynaphthalene:



Extracts of resting buds and catkins from various walnut trees around London were made in ethanol containing 5 per cent v./v. hydrochloric acid AnalaR, which inhibited enzyme action and rendered the extracts stable for one to two weeks when stored in the refrigerator under nitrogen. The clear green extracts diluted with acid alcohol or alcohol and examined in a Beckman Model DU spectrophotometer gave absorption curves with the following maxima :

~ 270, 283–285, ~ 305, 325, 342, ~ 360 mμ

(see graph). When these extracts were adjusted to *p*H 4·0 with N sodium hydroxide and chromatographed on alumina the following bands were obtained (reading from top): dark green, light greenish-yellow, lilac (turning green in acid alcohol). On development with 60–70 per cent alcohol the lilac band readily washed out of the column and was collected with the filtrate. Mineral acid was needed to remove the other two bands. The filtrate contained practically the whole of the dye reductants present in the original extract and showed maxima at 225, 305, 326 and 342 mμ in acid alcohol. The relative intensities of the peaks were unaffected by further adsorption on alumina, barium sulphate or lead acetate. Oxidation with $N/100$ iodine at *p*H 1 formed a yellow compound, soluble in ether, giving maxima at 249 and 425 mμ, corresponding with those for juglone.



Absorption curves of synthetic hydrojuglone — — —, of hydrojuglone derivative separated from male catkins of *J. regia* - - - -, and of the original acid alcoholic extract of the catkins ——. The maxima at 221–224 mμ for synthetic hydrojuglone and for the hydrojuglone derivative were obtained with dilutions of 1 in 4 and 1 in 5 respectively of the extracts used for obtaining the main parts of the curves

Hydrojuglone, which we prepared from juglone by reduction with zinc and hydrochloric acid, and by shaking out an ethereal solution of juglone with an aqueous solution of sodium hydrosulphite, gave the four maxima detected in the filtrate, but at slightly longer wave-lengths (namely, 225, 315, 334 and 348 mμ), these differences being probably due to ester formation in the natural product. The movement to shorter wave-lengths of the reduced form on esterification has been checked using juglone acetate. Such ester formation would also explain the much greater stability of the natural product as compared with synthetic hydrojuglone, which can lose most of its dye-reducing power and change back to a juglone within a few hours, especially on exposure to sunlight. Such change is accompanied by development of yellow colour, which also occurs when walnut extracts containing apparent vitamin C are titrated with the indophenol dye, and the increase in yellow colour thus produced has been found to be roughly parallel to the content of apparent vitamin C in numerous extracts prepared from different walnut tissues during the last two or three years. The dye titration value of synthetic hydrojuglone has been found to vary with the titration *p*H in the manner which one of us (F. W.)[6] has previously shown to be characteristic of apparent vitamin C in walnut extracts, thus clearly distinguishing it from reductone and other possible constituents of apparent vitamin C.

The occurrence of hydrojuglone in different walnut tissues has been known for many years[7]. We have not been able to find in the literature any reference to naturally occurring compounds of hydrojuglone or to its possible relationship to vitamin C. More recently, Lugg and Weller[8] considered the possibility of hydrojuglone being present among the non-specific dye reductants in walnuts, but (owing probably to their attention being concentrated on fairly mature fruit) did not find any significant amount of it in their experimental materials. Our spectroscopic and dye titration results show that in resting buds and catkins there may be more than 3 per cent of hydrojuglone, calculated on the fresh material, and accounting for practically the whole of the dye titration. During growth and development this percentage gradually falls, concurrently with a steady increase in the concentration of ascorbic acid. Our evidence indicates that in growth and development of walnut tissues hydrojuglone, in association with ascorbic acid, may play a more important part than has hitherto been suspected. We hope to publish more details later.

We are indebted to Dr. R. Melville, of the Royal Botanic Gardens, Kew, for samples of walnuts and botanical information, and to Miss Nora Baxter and Miss Elaine Finnegan for assistance in preparation of numerous extracts.

This investigation forms part of the work for a University of London Ph.D. thesis by one of us (C. D.).

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Frank Wokes

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April 23.

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[2] Wokes, F., Organ, J. G., Duncan, J., and Jacoby, F. C., *Biochem. J.*, 37, 695 (1943).
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Effect of Salt on Partition Chromatograms

The adverse effect of salt on partition chromatograms on paper has been mentioned by Consden, Gordon and Martin[1], and a method for removing salt from mixtures of amino-acids and peptides has been recently described by these authors[2]. If such desalted solutions are then fractionated on paper chromatograms and the individual spots washed off the paper and hydrolysed with $6\,N$ hydrochloric acid in capillary tubes, some salt is reintroduced, presumably from the glass. Electrodialytic desalting is now scarcely practicable owing to the number and very small volume of these solutions.

Fortunately, the amount of salt present is insufficient to prevent the final analysis of the hydrolysates on further paper chromatograms. Under these conditions, the effect of salt on the ninhydrin-treated chromatograms is usually seen as a yellow spot in the glycine – alanine region when phenol – coal gas – ammonia has been used as solvent. Sometimes there is also an opaque 'waterlogged' spot visible nearer the origin of the chromatogram while still wet with solvent. The salt effect is much smaller when 'Pyrex' instead of soda glass capillary tubing is used.

If the chromatogram, prior to treatment with ninhydrin, is extracted with toluene to remove traces of phenol and then sprayed, after drying, with thymol blue solution, a blue spot appears in exactly the same part of the chromatogram as would have been occupied by the yellow (ninhydrin) spot, thus indicating the presence of alkali in this area. Spraying with methyl red solution instead of thymol blue reveals a red (acid) spot nearer the origin corresponding to the position of the 'waterlogged' spot.

These effects were reproduced on chromatograms of amino-acids mixed with sodium chloride or sulphate (10–20 μgm. of each) and on chromatograms of these salts alone. The observations suggested that the alkalinity which often prevents the full development of the colours with ninhydrin of those amino-acids which occur in that region might be eliminated by the use of acidified ninhydrin solution. This proved to be the case when acetic acid (1 per cent v./v.) was added to the ninhydrin solution (0·1 per cent in *n*-butanol). With mixtures containing relatively high concentrations of salt, waterlogging becomes so important as seriously to distort the top part of the chromatogram, and the alkalinity may be sufficiently high to prevent entirely the development of the colours of glycine, threonine, alanine and tyrosine with unacidified ninhydrin. Nevertheless, even under these conditions, by the use of acidified ninhydrin, the colours of these amino-acids are revealed and show no distortion and no alteration of their R_F values. The separation of salts into cations and anions has also been observed with other solvent systems. With *s*-collidine, the effect is reversed, the acid spot being the faster and appearing in the valine – leucine region, and the alkali spot appearing near glycine.

It is hoped that these observations may be helpful to those investigators who are using chromatographic techniques.

P.S.—Since submitting this letter, we have seen the paper by Partridge and Westall[3], who also observe the separation of inorganic salts into ions, on paper chromatograms.

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[1] Consden, R., Gordon, A. H., and Martin, A. J. P., *Biochem. J.*, **38**, 224 (1944).

[2] Consden, R., Gordon, A. H., and Martin, A. J. P., *Biochem. J.*, **41**, 590 (1947).

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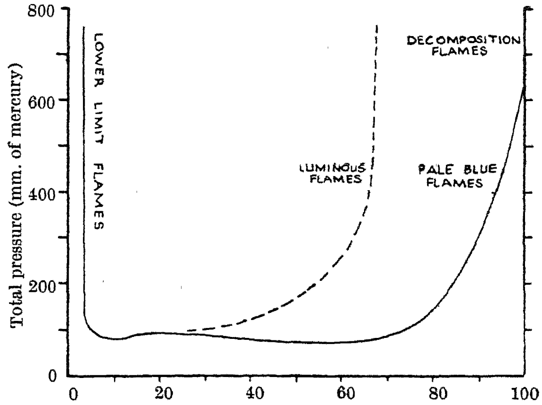
Ethylene Oxide Explosions

THE occasional occurrence of ethylene oxide explosions during the fumigation of dried fruit has led us to undertake a detailed study of the combustion characteristics of the vapour. An examination of the effect of pressure on the spontaneous ignition temperatures has yielded results somewhat like those for acetaldehyde[1,2]. Cool flames can be *initiated* in ethylene oxide – air mixtures in the neighbourhood of 330° C. at atmospheric pressure.

The effects of pressure on flame propagation in ethylene oxide – air mixtures have been observed in a closed glass tube, 5 cm. in diameter, using hot-wire ignition. With the tube vertical and ignition at the lower end, continuing flame propagation can occur at atmospheric pressure in all mixtures containing more than 3·6 per cent of ethylene oxide. With increasing proportions of the combustible above the lower limit, the flame changes from non-luminous to luminous in the usual way, and approaching about 68 per cent a normal upper limit flame is obtained. Beyond this point, however, the flame loses its luminosity and becomes pale blue; this continues while any air is present in the mixture. In the absence of air, ethylene oxide propagates an even less luminous blue decomposition flame, but at a higher speed and with greater pressure increase.

The effect of reduced pressure on these phenomena, under the conditions of experiment, is shown in the accompanying graph. The decomposition flame is propagated down to 630 mm. pressure; but below this an upper limit for ethylene oxide – air appears and the inflammable range is narrowed, being finally eliminated at about 70 mm.

Neither the blue flame with rich mixtures nor the decomposition flame is propagated vertically downwards, and under such conditions an upper limit is observed corresponding approximately to the boundary for luminous flames shown as a broken line in the graph.



The blue flame obtained with the rich mixtures no doubt corresponds with that observed under slightly different conditions by G. W. Jones and R. E. Kennedy[3], and by R. M. Jones[4] with mixtures containing up to 80 per cent of ethylene oxide. Coward and Jones[5] suggest that the flame is analogous to the cool flame of diethyl ether, but our investigations indicate that this is not so. The flame is, in fact, initiated at too high a temperature and too low a pressure for such to be the case, and we have tentatively formed the opinion that it is associated with the endothermic character of ethylene oxide. Very similar behaviour has been noted by Forsyth and Townend[6] using ethylene – air and ethylene – oxygen mixtures, and recently, Mr. G. Williams-Leir, working with one of us in this Department, has obtained further evidence of a range of non-luminous flames beyond the recognized upper limit of ethylene in air at atmospheric pressure[7].

We have also succeeded in establishing limiting conditions of temperature and pressure for the spontaneous explosive decomposition of ethylene oxide, and are studying the kinetics of the explosion limit in relation to the work of earlier investigators of the kinetics of the slow decomposition[8-10].

The investigation as a whole is being continued and detailed results will be published in due course.

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April 5.

[1] Kane, G. P., Chamberlain, E. A. C., and Townend, D. T. A., *J. Chem. Soc.*, 436 (1937).

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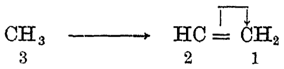
Radical Addition Reactions

VARIOUS theories have been advanced to explain the direction of addition of neutral unsymmetrical radical reagents to unsymmetrical unsaturated systems. Such addition is often 'abnormal' as compared with the 'normal' additions observed with ionic reagents. Thus Waters[1] states that "free radicals . . . react preferentially at points of high electron density", and Mayo and Walling[2] have suggested that the direction of addition is governed by the relative heats of formation of the two alternative intermediates in the addition. No disagreement with the views of the latter authors can be advanced because there is, in general, no method of accurately evaluating such constants. The statement by Waters, on the other hand, is not in agreement with the present experimental data, since his view would imply that neutral radicals are electrophilic in character.

Recorded observations on the addition of radicals to unsymmetrical unsaturated systems can be explained if it is presumed that radicals attack preferentially at points of high 'differential electron density' —differential, that is, with respect to the symmetrical *unsubstituted* systems. Examples will make this clear. With benzene, already substituted by either *o*-, *p*- or *m*-directing groups, the greatest differences in electron density with respect to unsubstituted benzene occur at the *o*- and *p*-positions ; the *m*-position is relatively unaffected. Free radicals attack benzene derivatives principally at the *o*- and *p*-positions[3].

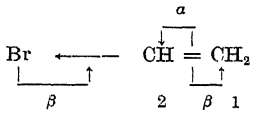
In propylene the inductive effect ($+I$) of the methyl group is usually considered to initiate a mesomeric effect as in (I), which more than compensates for the drift of electrons from C_3 towards C_2.



I

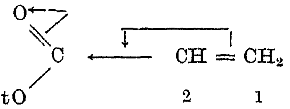
C_1 is thus more negative than C_2 and also has the higher differential electron density with respect to unsubstituted ethylene ; in agreement, atomic bromine, in abnormal addition, adds to C_1.

A similar argument applies to (say) vinyl bromide (II). Here the position is more complicated in that the inductive effect ($-I$) of the bromine atom initiates the mesomeric effect (α), which in turn is partially compensated by the mesomeric effect (β). Although (β) is of dominant importance for ionic addition, where it becomes an electromeric effect in the transition state, the negative end of the dipole in vinyl bromide lies at the bromine atom, thus showing that (α) is more important in the unexcited compound. Following the argument given for propylene, the position of maximum differential electron density is at C_1 in agreement with the direction of 'abnormal' addition of bromine atoms.



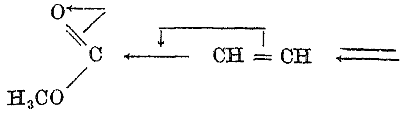
II

In α : β-unsaturated esters, such as ethyl acrylate (III), both ionic and radical addition of unsymmetrical addenda furnish the same products[3]. This is again in agreement with prediction. The $-CO_2Et$ group exerts an inductive effect ($-I$) on the ethylenic linkage and also the mesomeric effect ($-M$) illustrated. For electrophilic attack C_2 obviously has a greater electron density than C_1, as indeed is shown by the direction of electrophilic ionic addition, which is contrary to the Markownikoff rule. But radical reagents, like bromine atoms, do not attack C_2 but C_1, where the differential electron density is clearly greater than at C_2. This last example is one where it is possible to distinguish without ambiguity between the predictions of Waters' theory and the one propounded here.

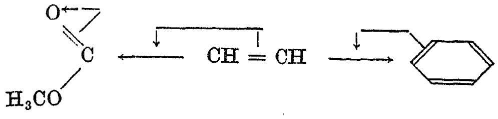


III

It has recently been shown by Koelsch and Boekelheide[4] that aryl radicals add to the β-position in methyl crotonate (IV), but to the α-position in methyl cinnamate (V). Such reversal of addition is easily understood when it is remembered that the inductive effect ($-I$) of the carbomethoxyl group is greater than that due to phenyl, and that the change in electron density at the β-carbon atom in methyl cinnamate, due to the mesomeric effect ($-M$) imposed by the carbomethoxyl group, is compensated by the mesomeric effect ($+M$) of the phenyl group.



IV



V

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March 23.

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[1] Waters, W. A., "The Chemistry of Free Radicals", 183 (Oxford University Press, 1946); compare Kharasch, M. S., Engelman, H., and Mayo, F. R., *J. Org. Chem.*, **2**, 288 (1937).

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[3] Price, C. C., "Mechanisms of Reactions at Carbon-Carbon Double Bonds", 63 (Interscience Publishers, Inc., 1946); see also Remick, A. E., "Electronic Interpretations of Organic Chemistry", 275 (J. Wiley and Sons, 1943).

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DR. BARTON's term 'high differential electron density' is quite useful for explaining more precisely my early, and vague, statement that "free radicals attack molecules preferentially at points of high electron density"[1]. Obviously *electron-availability* is an essential requisite for free radical reactions. Free neutral radicals, such as $Br\cdot$, $CH_3\cdot$, or $C_6H_5\cdot$, are electrophilic reagents in so far as they tend to complete their electron octets, and this end they can achieve (*a*) by combining with another unpaired electron, as in $CH_3\cdot + \cdot NO \rightarrow CH_3{-}NO$; (*b*) by combining additively at one of the easily available π-electrons of an olefinic bond; or (*c*) by abstracting an outer atom *plus* one electron from another molecule, as in $Cl\cdot + HCH_3 \rightarrow Cl{-}H + \cdot CH_3$. The ease of reaction is $a > b > c$, and this is the order of available electron densities at the atom which is attacked.

Dr. Barton concerns himself with process (*b*), and here it is the differential electron density at the two ends of the π-electron bond of the olefine which is important. It is to be judged, as he points out, by taking into account both inductive and mesomeric effects of substituents upon the static structure of the olefine, but not the inductomeric or electromeric processes which arise when an olefine molecule becomes polarized by an approaching heterolytic reagent[1]. One should remember, however, that these radical reactions are all bimolecular, and hence the essential criterion of the reactive tendency is the energy difference between the initial and the transition states. Often, as in the cases of vinyl bromide, ethyl crotonate and ethyl cinnamate, this energy difference can be gauged most easily by writing down the structures of the alternative radical addition products; for example, $Br{-}\dot{C}H{-}CH_2{-}Ph$ and $Br{-}CH(PH){-}CH_2\cdot$, where mesomerism is obvious in the former, but nct in the latter, case. This, of course, is the point of view of Mayo and Walling, and is much more accurate than my original electron density picture, which was not intended to cover all mesomeric systems.

In the case of aromatic systems, Dr. Barton's description of the experimental facts, though unfortunately current, is somewhat misleading, since the substitutions of aromatic compounds by free radicals have not, on account of inherent practical difficulties, been studied quantitatively. It would be truer to say that whereas the *para*-substituted product can always be isolated, both the *ortho*- and the *meta*-isomeride are often formed in comparable amount. Forthcoming papers in the *Journal of the Chemical Society* by Prof. D. H. Hey and myself will deal with this question.

W. A. Waters

Balliol College,
Oxford.
June 3.

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[1] Waters, *Trans. Farad. Soc.*, **37**, 770 (1941).

Nickel Plating by Chemical Reduction

Brenner and Riddell[1] have described a method for nickel and cobalt plating by chemical reduction of the metal salts with sodium hypophosphite under both acid and alkaline conditions. Aside from its utility, this reaction is one of considerable interest by virtue of its catalytic nature. Thus, in the concentrations they use, deposition occurs only if certain metals are immersed in the solution and, even in their presence, deposition is inhibited by the addition of such materials as potassium thiocyanate and lead in small amounts. It is suggested that some insight on both these effects and also on the unusual kinetics of the reaction is obtained by the mechanisms outlined below.

I. *Alkaline Solutions.* The initial reaction step is one of electron transfer involving nickel and hydroxyl ions at the catalytic metal surface, *M*.

$$Ni^{++} + M = Ni^{+} + M^{+} \quad (1)$$

$$OH^{-} + M^{+} = OH + M. \quad (2)$$

$$2Ni^{+} = Ni + Ni^{++} \quad (3)$$

$$H_2PO_2^{-} + 2OH = H_2PO_3^{-} + H_2O. \quad (4)$$

The overall reaction is:

$$Ni^{++} + H_2PO_2^{-} + 2OH^{-} = Ni + H_2PO_3^{-} + H_2O.$$

The interchange of electrons between the nickel ion and the surface will, following Michaelis[2], take place in one-electron steps. The Ni^{+} ion first formed can then acquire another electron or disproportionate[3] to give the atom as in reaction (3).

This mechanism accounts for: (i) The necessity of a metal surface to act as an electron source and sink as in reactions (1) and (2). The generally unfavourable free energy change[4] of reactions as $OH^{-} + M_{aq.}^{++} = OH + M_{aq.}^{+}$, where $M_{aq.}^{++}$ is the ion in solution, shows this oxidation-reduction reaction not to involve dissolved ions of the catalytic metal but electrons present at various levels in the bulk metal as such. (ii) The non-catalytic nature of glass and plastic in their inability to take part in the electron transfer reactions (1) and (2). (iii) The action of inhibitors and the incidence of passivity in their effect on the electron availability at the surface. (iv) The independence of reaction-rate on the nickel concentration in the rapid nature of the electron transfer steps. (v) The dependence of the rate in linear fashion on the hypophosphite concentration in reaction (4), which involves an atom transfer step. This reaction is favourable thermodynamically, ΔG being approximately -130 k.cal.[4].

II. *Acid Solutions.*

$$H_2PO_2^- + M = H_2PO_2 + M^- \qquad (5)$$

$$H_2PO_2 + H_2O = H_2PO_2 + OH. \qquad (6)$$

The reactions of the nickel ion remain as given above. The overall reaction is:

$$H_2PO_2^- + Ni^{++} + H_2O = H_2PO_3^- + Ni + 2H^+.$$

This mechanism differs from that in alkaline solution in the nature of the anion primarily involved in the electron transfer step at the metal surface—reaction (5). The unusual features of the deposition reaction in acid media accounted for include: (i) The independence of rate on both nickel and hypophosphite concentration, since both ions take part in electron transfer steps at the metal surface. The hypophosphite radical first formed afterwards reacts with water to give the OH radical and hypophosphorous acid, which, as they are formed in juxtaposition, will rapidly interact to give the final products of oxidation. This reaction has a free energy change of − 130 k.cal.[2]. (ii) The increase in deposition-rate with agitation of the metal surface is due to impoverishment at the surface of the ion $H_2PO_2^-$.

A curious feature of unexplained origin is that, in mixed nickel–cobalt solutions, only the former is deposited, providing the process is worked under acid conditions.

I wish to thank Mr. D. A. Dowden for helpful discussions.

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April 9.

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Deamination of Amino-Acids by X-Rays

Recently we have isolated products of hydroxylation from dilute aqueous solutions of benzene and benzoic acid irradiated with ionizing radiations (X-rays, γ-rays, neutrons)[1]. The formation of phenolic compounds in these experiments furnished experimental evidence in support of the theory put forward by one of us[2] in 1944, according to which the primary action of ionizing radiations results in the splitting of the water molecules according to

$$H_2O \rightarrow \ldots\ldots \rightarrow OH + H,$$

presumably through the ions H_2O^+ and H_2O^-. These reaction products are similar to those obtained from the same substances by the action of OH-radicals produced chemically (for example, by the hydrogen peroxide – ferrous salt system), or in the biological oxidation of these substances[3]. We have now found that irradiation by X-rays of dilute aqueous solutions of certain simple amino-acids results in an (oxidative) deamination yielding ammonia, and the corresponding aldehydes similar to those obtained from the same substances *in vitro* by the action of OH-radicals produced chemically[4].

The experimental conditions were similar to those reported previously[1]. For example, aqueous solutions of serine (100 ml. solution containing 400 mgm.) were irradiated with doses of the order of 10^6 r. units. The ammonia formed in the irradiated solution was determined by the method of Parnas[5]; the yield being of the order of 0·3 millimoles. (The yields reported in our previous communication also refer to 100 ml. of solution.) The glycolaldehyde was isolated as the dinitrophenylhydrazine derivative (m.p. 156°)[6]. The presence of hydroxypyruvic acid was indicated by positive colour reactions[7].

Corresponding products were isolated in varying yields from irradiated solutions of other simple amino-acids. Full details will be published elsewhere.

The irradiations were carried out at the X-Ray Department of the Royal Victoria Infirmary, Newcastle-upon-Tyne. We are greatly indebted to Dr. F. T. Farmer, who has made all the quantitative determinations of X-ray dosage.

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April 6.

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Influence of Low Temperatures on the Mechanism of the Austenite – Martensite Transformation

Systematic investigations have been carried out on the influence of low temperatures on the lattice parameter of austenite and martensite and on the axial ratio c/a in martensite.

Two plain carbon steels were chosen containing 0·89 per cent and 1·2 per cent of carbon respectively. In order to obtain a martensite structure, the samples were quenched from 930° in brine solution after holding for 15 min. at this temperature in a carbon monoxide atmosphere. Rods of 0·5 mm. diameter were cut from the quenched specimens by cutting very slowly with a carborundum wheel, applying efficient water-cooling. The rods were afterwards etched in order to remove the surface layer.

X-ray photographs of the rods from these steels were taken in 9-cm. and 19-cm. Debye – Scherrer cameras using cobalt radiation and an iron filter. The rods were then immersed in liquid air for one hour and liquid nitrogen for 30 min. and X-ray diffraction photographs again taken. In certain cases, instead of using liquid air or nitrogen, some of the rods were immersed in a liquid helium bath at about 1·5° K. for approximately 6 hr. After liquid air or liquid nitrogen treatment and X-ray examination, some of the rods were treated in liquid helium and examined by X-ray diffraction methods again.

The photographs were photometred by means of the Hilger non-recording X-ray microphotometer. Readings were taken at intervals of 0·1 mm. and sometimes in more interesting cases 0·01 mm. along the entire length of all films, and correction for non-linearity in the blackening intensity curve was made from calibration strips put on the film by means of a rotating stepped sector. This correction was necessary in only a few cases.

The lattice parameter was measured. A value for the axial ratio was obtained from M_4, using the designations adopted by Lipson and Parker[1], and this was used in calculating c and a from each of the lines M_6. The value a was also obtained from M_8 (220) and the true value was found by extrapolating linearly from $\sin^2 \theta = 0$ to $\sin^2 \theta = 1$.

The lattice parameter c of the martensite decreases, while the parameter a shows very little change. The diminution of the parameter c in liquid helium is much more noticeable than in liquid air or nitrogen.

The axial ratio c/a in tetragonally distorted martensite[2] distinctly decreases after the specimen is immersed in liquid air or nitrogen. The ratio c/a decreases very strongly after cooling the specimen in liquid helium.

The lattice parameter of austenite decreases after the specimen is cooled in liquid air and nitrogen, and especially after cooling in liquid helium.

The immersion of the specimens in liquid air, nitrogen or helium has apparently the same effect as the shift in the position of the smaller carbon content in Honda and Nishiyama's[3] curves, which show that the c and a lattice parameters for martensite, their ratio c/a and the a lattice parameter for austenite vary linearly with the carbon content.

Investigations on the breadths of X-ray diffraction lines and grain size of martensite and austenite are in progress and a full report on the subject will be published elsewhere in the future. This work has been carried out in the Royal School of Mines, London, under the direction of Prof. C. W. Dannatt. Grateful acknowledgment is due to Prof. J. F. Allen for facilities in the Royal Society Mond Laboratory, Cambridge.

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Photodisintegration of the Deuteron

THE photodisintegration of the deuteron into a proton and a neutron is a case of the two-body problem in nuclear physics; the effect was first discovered by Chadwick and Goldhaber[1]. Accurate measurement of the cross-section for this effect can give information about nuclear forces which is of interest in view of the several theories which have been put forward recently[2-5]. These theories predict values between 13 and 17×10^{-28} cm.^{2}. The cross-section has been measured three times before[1,3,6]; but since these values are all considerably below those predicted by theory, and in view of the significance of this constant, it was thought worth while to make use of improvements in technique that have been made in the meantime.

The measurement was made by direct counting of the photoprotons in an ionization chamber filled with deuterium to a pressure of six atmospheres using a calibrated source of radiothorium, which gives 2·62-MeV. γ-rays. This method is independent of a neutron standard and also avoids counting the disintegrations caused by the 2·2-MeV. line emitted by such a source[6,7]. To ensure counting of all photoprotons, which have an energy of only 0·2 MeV., in the presence of the strong γ-radiation, electron collection is essential. To achieve this at six atmospheres pressure the hydrogen must be exceptionally pure (less than 1 part in 10^6 of oxygen). We were greatly encouraged in attempting to obtain electronic conduction in a metal ionization chamber by the work of Mr. G. H. Stafford[8], using extremely pure hydrogen in an all-glass ionization chamber. The counts were found to be reproducible from day to day within 2 per cent.

The source was placed at 1 metre from the chamber, at which distance (52·5 ± 1) counts per minute were observed. In order to obtain the cross-section from this observed rate of counting of photoprotons, the following facts must be known.

(1) The γ-ray flux. The radiothorium source was compared with a radium standard using an ionization chamber similar to that used in the Curie Institute in Paris, so that the absolute millicurie content could be calculated using a result of Ricoux[9]. It is well known that one 2·62-MeV. γ-ray is emitted for every disintegration of the thorium-C″ nucleus, with the exception of the few disintegrations (1 in 10^4) which give a long-range α-particle. The branching factor (0·35) is also well known[7]. A correction of 6 ± 0·5 per cent has to be made for the absorption of γ-rays in the brass walls of the ionization chamber.

(2) The sensitive volume of the ionization chamber. The chamber is a closed cylinder with a small hole for entry of the collector electrode. The cylinder is connected to a negative high voltage (5 kV.), which is ten times the saturation voltage to ensure complete collection. The sensitive volume is then assumed to be the geometrical volume (51·7 ± 0·2 c.c.), which was obtained by filling with distilled water and weighing. Corrections have to be made for those photoprotons which lose most of their energy in the walls (5 ± 1 per cent at this pressure) and for the region in the immediate vicinity of the central wire which is insensitive because of the effect of positive ions. Use of a cylindrical chamber with a small collector makes this correction small (2·2 ± 0·5 per cent).

(3) The pressure in the ionization chamber. This was obtained by expanding into a known volume and reading the pressure on a mercury manometer. This, when corrected to N.T.P., gives 6·01 ± 0·03 atmospheres.

(4) The purity of the gas in the chamber. This was afterwards checked with a mass spectrometer. The gas entered the mass spectrometer through a palladium leak giving an assumed enrichment for the lighter isotope of 1·33. Using this figure, the purity of gas was 95 ± 1 per cent deuterium.

The final result for the total cross-section (magnetic plus electric photo effect) is: $\sigma = (16\cdot 2 \pm 1\cdot 0) \times 10^{-28}$ cm.^{2}.

It is interesting to compare this result with the predictions of meson theory. The results of recent theoretical calculations of the total photo-nuclear cross-section have kindly been sent to us by Prof. Hulthén and are given below (see also L. Rosenfeld[4] and Pais[5]).

Type of meson theory	Assumed meson mass	$\sigma \times 10^{28}$
Møller–Rosenfeld	197	15·1
Neutral	197	16·8
Møller–Rosenfeld	296	13·3
Neutral	296	13·7

Our result therefore eliminates the substantial discrepancy with theory which previously existed, and favours a light meson mass. The precision of our measurements is insufficient to decide between the different types of theory.

We have to thank the Ministry of Supply for the loan of the radiothorium source, the Department of Scientific and Industrial Research for a maintenance grant, Dr. Reaf and Mr. Thoneman for the analysis of the deuterium, and Lord Cherwell for his continued interest in the work.

Note added in proof.—Dr. Gentner has kindly pointed out to us that the high value obtained for the cross-section could be due to a γ-ray line at 3·2 MeV. of uncertain intensity reported by Simons and Zuber (*Proc. Roy. Soc.*, **159**, 383 ; 1937). An examination of our proton energy spectrum shows that the line (if it exists) has an intensity too small to influence the result.

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H. Halban

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June 10.

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Nuclear Isomeric Transitions of Short Periods

THE elements copper, molybdenum, silver, cadmium, indium and lead have been irradiated by a pulsed beam of X-rays, activity ascribable to metastable states being sought in the intervals between pulses. The electrons producing the X-ray pulses had energies up to 1·05 MeV., the pulse width was 5 μsec., repetition frequency 200 per sec. and mean current 15 μamp. ; the mean current during the pulse was thus approximately 15 m.amp. The elements were irradiated within Geiger–Müller counters, counts between pulses being displayed on an oscillograph with time-base triggered by the pulses. No evidence of activity was obtained. Periods greater than 100 μsec. could have been detected. Some details are given below of the experimental arrangements whereby a particular spurious effect can be eliminated, since these may be of interest in similar studies where more energetic X-rays are available.

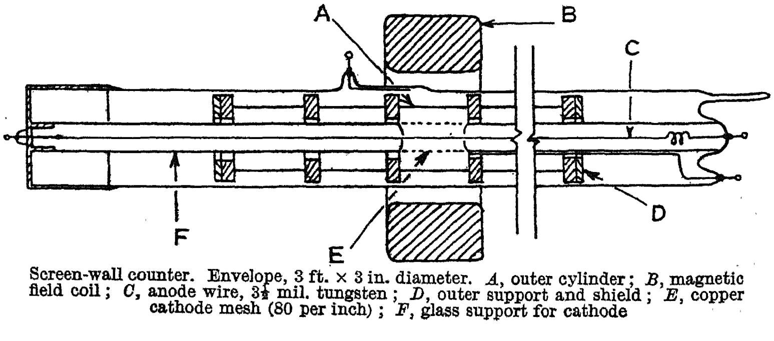
The electron beam was generated by a pulsed linear resonant-cavity accelerator, working at 1,200 Mc./s., constructed by the Radiophysics Division of the Council for Scientific and Industrial Research, Sydney ; an earlier type of accelerator, using similar principles, has been described[1]. As a result of developments by Mr. B. Y. Mills, of the Radiophysics Laboratory, electron energies up to 1·25 MeV. have been obtained with a single cavity.

When counters with the metals under investigation as cathodes and filled with argon (pressure 15 cm.) and ether (pressure 15 mm.) were irradiated, a short-period 'activity' dying away in approximately 0·01 sec. was observed ; a high X-ray intensity increased the counting-rate between pulses, in some cases to an apparently continuous discharge. In the copper cathode counter the counting-rate was less intense than in those with other metals as cathodes. These effects were shown to be extra-nuclear in origin as follows.

The six metals were placed within the envelope of a screen-wall counter; this type of counter[2] can be used for magnetic measurements of energies of particles produced by nuclear disintegration. The design adopted for the present experiments is shown in the accompanying diagram. The envelope is of glass, with one brass end ; the cathode is a cylindrical copper wire mesh, and the material to be irradiated a cylinder placed outside the cathode. By sliding each outer cylinder in turn into position facing the cathode, differences due solely to the different metals can be detected. A filling of argon–ether mixture up to 4 cm. pressure was employed, so that scattering effects could be neglected in the measurement of energies of any particles emitted from metastable nuclei. It was found that the application to the outer cylinder of a potential more than 2 volts above that of the cathode in each case reduced the counting-rate between pulses to a value not significantly different from that occurring when there was no outer cylinder facing the cathode mesh. Thus the counts between pulses could not have been produced by electrons of energy more than 2 eV. Their actual origin is being investigated.

The absence of any observed long-period activity with lead requires comment, as one might expect that the 1·6 min. isomer of threshold 0·65 MeV. previously discovered by Waldman and Collins[3] would have been produced by X-rays of maximum energy 1·05 MeV. However, an approximate calculation on the assumption of the yield quoted by the above experimenters shows that in the present experiments an increase in counting-rate of more than 5 per minute should not have been expected, and such a low rate would not have been regarded as significant. All known isomers in the other metals require more energetic X-rays for their activation.

With regard to short periods, the presence in lead of a metastable state with period of order 1 m.sec., if such existed with an activation cross-section of the order 10^{-34} cm.^{2} or more, could have been detected ; this estimate is based on the assumption of an activation-level at 0·65 MeV. It seems likely that there are no suitable activation-levels below 1·05 MeV. in the nuclei of silver[4], cadmium[4] and indium[5]. It is interesting to note that no isomeric transitions of periods of the order of 10^{-3} sec. have yet been reported, although some activities with



Screen-wall counter. Envelope, 3 ft. × 3 in. diameter. *A*, outer cylinder ; *B*, magnetic field coil ; *C*, anode wire, 3½ mil. tungsten ; *D*, outer support and shield ; *E*, copper cathode mesh (80 per inch) ; *F*, glass support for cathode micro-second periods have been discovered which are produced by radioactive decay into stable isotopes[6].

A study of the behaviour of nuclei immediately following nuclear reactions and inelastic collisions may show evidence of short-lived isomers. In order to examine such effects, it is proposed, using a method similar to that here described, to irradiate various materials with neutrons produced by a pulsed ion beam in a (D + D) generator.

Grateful acknowledgments are due to Dr. E. G. Bowen, chief of the Radiophysics Laboratory, for making available facilities for the experiments described, and to Dr. R. E. B. Makinson for suggesting this work. Financial assistance has been provided by a Commonwealth Science Research Grant.

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A Gravitational Field with a Curious Geometrical Property

IT is well known[1] that there are fourteen independent absolute scalar differential invariants of the second order associated with the gravitational metric,

$$ds^2 = g_{\mu\nu}\, dx^\mu\, dx^\nu. \qquad (1)$$

It can be argued that the vanishing of all the invariants need not imply the vanishing of all the twenty independent components of the curvature tensor R_{hijk}. On the other hand, it may be pointed out that, when the invariants vanish, there are fourteen differential equations to be satisfied by the ten $g_{\mu\nu}$ components; and it is not at all obvious that a gravitational field with a Riemannian metric exists for which the fourteen invariants vanish. We report here the existence of such a gravitational field described by the metric

$$\begin{gathered} dS^2 = -A(dx^2 + dy^2 + dz^2 - dt^2) \\ A = A(\xi),\ \xi = x - t, \end{gathered} \qquad (2)$$

for which the surviving components of the energy-momentum tensor satisfy the relations,

$$T_1{}^1 = T_1{}^4 = -T_4{}^1 = -T_4{}^4, \qquad (3)$$

each being equal to

$$\frac{1}{8\pi}\left[\frac{1}{A^2}\frac{d^2A}{d\xi^2} - \frac{3}{2}\frac{1}{A^3}\left(\frac{dA}{d\xi}\right)^2\right]. \qquad (4)$$

The above metric with the conditions (3) may be compared to the gravitational field corresponding to a directed flow of radiation as given by Tolman[2]. For (2), the conformal curvature tensor vanishes and $T_\mu{}^\nu$ has the structure of the electromagnetic energy-momentum tensor; these circumstances together being responsible for the vanishing of the complete set of invariants.

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K. R. KARMARKAR

Benares Hindu University.
April 12.

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Interpretation of Data from Electrical Resistivity Geophysical Surveys

MR. J. M. HOUGH has described in *Nature* of May 22 a graphical method of analysing results from the four-electrode method of determining electrical resistivity, when applied to a horizontally stratified earth. He cites particularly the case of a two-layer earth. In a paper published in the *Proceedings of the Physical Society*, **47**, 589 (1935), we described this graphical method and gave the universal curves for the case when the four electrodes are equally spaced. The analysis for the distribution of an alternating current with parallel flow in a two-layer earth was also given. Comparisons were made between results obtained with alternating currents and those obtained with the four-electrode method.

The graphical method just mentioned was used to some extent in the preparation of the electrical resistivity maps of Great Britain and southern Scotland issued by the Electrical Research Association in 1935.

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W. G. RADLEY

General Post Office.

BEFORE I commenced an investigation of the interpretation of data from electrical resistivity surveys, unfortunately I failed to find any reference to the paper by Drs. Whitehead and Radley.

There are two points in the treatment of this method by Drs. Whitehead and Radley on which I should like to comment. They suggest that this method is not as accurate as that due to Tagg. For the ideal case of two perfectly homogeneous layers separated by a plane boundary parallel to a perfectly plane surface of the earth, this is probably true. In actual surveys, these conditions are never completely fulfilled, and deviations caused by irregularities in the boundary planes and inhomogeneities in the layers make any two-layer curve into only an approximation to the actual curve: under these conditions, I suggest that either method would be equally applicable.

In their paper, Drs. Whitehead and Radley only apply the method to a two-layer problem. I believe that the method is especially useful in the case of certain types of multi-layer earth. In my communication, I did not discuss this at length as the method is essentially the same as that proposed by Tagg, but, in my opinion, very much more convenient than that of Tagg. I have used the method on some results obtained by Prof. L. S. Palmer in Holderness for deposits which have three main layers, topsoil, low-resistance boulder clay (this layer is not usually homogeneous but contains thin strata of sand, etc.), and high-resistance chalk. In the eight cases examined, four showed a curve of three-layer type, and for these the specific resistance of the boulder clay ranged between 130 and 80 ohm ft., and that of the chalk between 240 and 570 ohm ft. The topsoil varied from 2½ ft. and 6 ft. in thickness, and in two cases where bore-hole data were available the chalk was within 10 per cent of that for the bore-hole.

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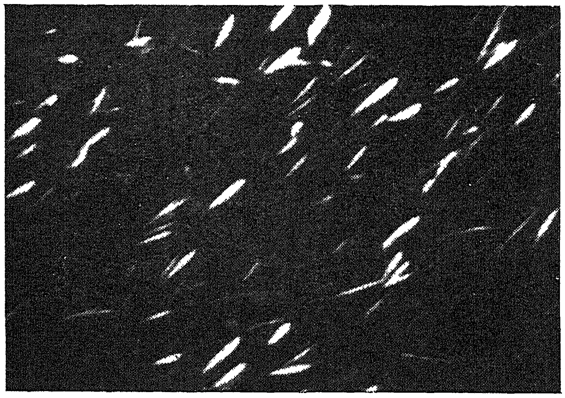
Open Hearth Furnace Models

A DESCRIPTION was given in a letter in *Nature* of March 27, p. 479, of the use of aluminium powder for flow visualization in a water model of an open hearth furnace. It has since been shown that part of the pattern was due to air bubbles, and that if these are eliminated the aluminium shows up as extremely short light streaks due to the rapidly changing orientation of the disk-shaped particles during the exposure period.



At the suggestion of Mr. F. H. Saniter, director of research, further tests were made in which a stream of gas (initially oxygen) was introduced into the water before the 'checkers', after all the original bubbles had been eliminated by suitable adjustment of the control valves. This technique resulted in an immediate improvement both in the ease of observation and photographic clarity. Not only were the individual bubble streaks far more clearly discernible, but also the falling off in light intensity of the flash from the discharge tube during the exposure results in a point on the tracks that enables their direction of movement to be easily recognized. This latter feature is proving a great asset in the study of such highly turbulent conditions.

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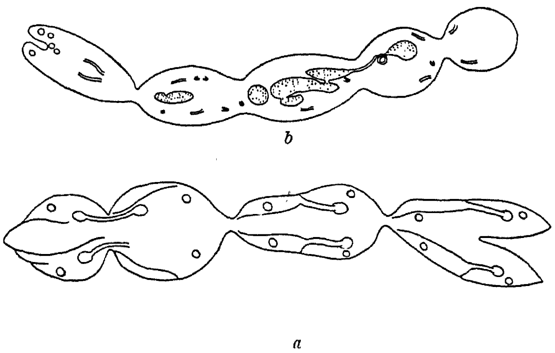
Induced and Spontaneous Abnormality in Ciliates

MOTTRAM[1,2], by means of various physical agents and by means of certain cyclic hydrocarbons—all factors, except one of the latter group, said to be carcinogenic—disorganised a ciliate and found some persistence of abnormality in the offspring of the disorganised cells. At first he named the ciliate *Paramecium aurelia*[1] and later *Paramecium* and *P. colpoda* Ehr., but finally adjusted the identification to "an amicronucleate race of *Colpidium*"[2]. It is important to realize that his ciliate, being without a micronucleus, was intrinsically abnormal. In the reaction he suggested an analogy to tumour formation and surmised that where such abnormals arise spontaneously in culture there has been unwittingly some exposure to a carcinogenic factor.

Such abnormalities, the origin of which is in a double cell, have been produced by merotomy[3,4], by exposure to sodium bromide[5], hydrogen cyanide[6], benzene hexachloride ('Gammexane')[7], by transfer of a culture to hard chlorinated tap water[8]; also as a sequel to conjugation[9].

In the case of 'Gammexane' and *Paramecium caudatum*, up to a 56 per cent conversion to an abnormal form has been obtained. These double cells become monstrous and multinucleate. They give rise to both normal and abnormal cells, but usually there is no suggestion of persistence of abnormality, which disappears at the death of the primary or secondary abnormal forms. One of ninety such cases closely followed has behaved differently, with constant difficulty in parting of the cells at division, and yielding frequent double cells, various distorted individuals and monsters for six months until the clone was abandoned. The greatest development of abnormals occurred eight to ten weeks after the exposure to 'Gammexane'.



Chain-forming spontaneous abnormal *Paramecium caudatum*. *a*, From life, showing doubling of mouths and contractile vacuoles and bifid tendency. *b*, Showing disorganisation of nuclei and intercalary division. Macronuclei are shown stippled, healthy micronuclei as black dots, degenerate ones as circles, gullets as slits

In spite of the fact that this experience was unique in the series, it would have been attributed to a residual effect of the 'Gammexane'; but, about the same time, a double cell appeared in a stock culture which formed part of the control. This spontaneous instance has maintained abnormality in its offspring for more than a year, and the clone is still vigorous though with a morbid tendency. The cells are extremely sticky in division, so that chains of up to nine cells are produced. There is a tendency to bilateral symmetry in organelles, but the nuclei in the chains are completely disorganised (see figure). It gives off normal cells, and normal side-lines can be obtained by selection. In some respects it resembles a case reported by Jennings[10] which also arose spontaneously but has better viability as the chains will live alone in culture, whereas his died unless normal cells were included to aerate the medium. He recorded no doubling of organelles and did not report on nuclear conditions. The stock cultures, maintained in 0·5 per cent linseed infusion, were exposed to no conceivable carcinogenic agent, and the origin of this abnormal clone was, without doubt, due to some intrinsic cause.

In the light of such observations, the basis of Mottram's hypothesis does not exist. Nevertheless, having regard to the present wide use of benzene hexachloride as an insecticide, it was thought wise to test it for possible carcinogenicity (see following letter).

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Absence of Carcinogenic Activity of Benzene Hexachloride ('Gammexane')

FOR reasons given in the preceding letter, benzene hexachloride has been tested for carcinogenic properties. A 0·5 per cent solution in acetone has been applied twice weekly for fifteen months to the interscapular skin of a group of thirty mixed stock mice. A further twenty mice were subcutaneously implanted with pellets of paraffin wax containing 3 per cent of 'Gammexane', and have since been observed for ten months.

No tumours have been induced in either group. Moreover, there have been none of the changes seen with known carcinogens during the latent period, for example, epilation, local thickening and congestion of the skin, epidermal hyperplasia, and fibrillary changes in the dermis of the first group[1]; or the characteristic failure to form a firm collagenous capsule round the pellet in the second group[2]. The survival-rate has been satisfactory, twenty-one and twelve out of the original thirty and twenty respectively being still alive at the time of writing. Of the dead mice, one showed leukæmia at autopsy and another was killed following the observation of a carcinoma of the breast; both these lesions occur spontaneously in the stock, and there is no reason to attribute them to the treatment.

It is perhaps worthy of mention that the general condition of the mice in the first group has been definitely superior to that obtaining in an average experiment; this we attribute to the reduction of parasitic cutaneous infestation. In certain types of prolonged experiment, periodical treatment of the animals in this way might prove of general value.

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Rhythmic Respiration in the Sea Urchin

I AM much interested in the note by Dr. Erik Zeuthen on the presence of rhythmic respiration in sea urchin eggs[1]. Fifteen years ago, while at Harvard, I performed a number of experiments on the fertilized eggs of another species of the sea urchin, *Arbacia punctulata*, using the Warburg microrespirometer technique. I found rhythmic variation in the rate of oxygen consumption by these more or less uniformly cleaving eggs. The phenomenon is quite pronounced at 25°, but not so at 15°. The oxygen consumption *v.* time, or oxygen consumption *v.* cleavage curves are very much the same as those given by Dr. Zeuthen. I also discussed in detail the reasons for the failure of previous workers to find such variations. In Warburg's first experiments[2] the readings were taken at too long intervals, and Gray's[3] experiments were made at too low a temperature (11°) for the variations to be significant. Shearer's data actually showed such a variation if his data were replotted differentially as rate against time, rather than as an integral curve of amount of oxygen consumed against time, which was the way he plotted the results.

The results of my experiments, together with the discussion, were published, upon my return to China, in *Wuhan University Journal of Science*, 7, 1 (1937). Unfortunately, war broke out soon after, and very few copies of the journal are in existence now. Even I myself have no copy. I am trying to locate this article, both in China and in libraries abroad.

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Use of Rotifera for Testing Analgesics, Narcotics and Similar Drugs

THE assay of the analgesic power of therapeutic substances by means of rats cannot be carried out with any degree of precision. It has been found that the Rotifera can be employed for this purpose since they are extremely sensitive to killing agents unless they are previously narcotized[1].

Through the courtesy and active help of Mr. E. D. Hollowday, regular supplies of the rotifer, *Brachionis calyciflorus*, were obtained, and lots of 1·0 ml. of the water containing 10–15 of the Rotifera pipetted into small tubes. An equal volume of a solution of the drug under test at a known concentration was slowly added, the tube being gently rotated to ensure even mixing. After allowing to stand for 10 min. the Rotifera were examined under the microscope. After noting their condition, the animalcules were killed with formalin and the state of the cilia determined.

The various states were defined as follows:

(i) *Dead*. These had died from 'natural' causes and generally consisted of the lorica containing a more or less decomposed internal mass.

(ii) *Killed*. These had contracted on contact with the formalin or other drug without passing through a state of narcosis. This was indicated by contraction of the cilia, generally accompanied by contortion of the internal organs.

(iii) *Narcotized*. These showed no contraction or contortion, the Rotifera being free from movement but with the cilia outstretched. On the addition of formalin, no immediate obvious changes took place.

(iv) *Alive but not narcotized*. These were either static or else free-swimming with the normal movement of the cilia. On the addition of formalin, they contracted and contorted within the lorica.

The relative numbers in the three classes, killed, narcotized, and alive but not narcotized, were counted.

The effect of various drugs was examined throughout ranges of concentration depending on the activity of the particular substance under investigation. The first compound examined was acetylsalicylic acid, and as the pH value of the solution was *c.* 3·3, the other substances were used at approximately this degree of acidity, except in the cases of sodium salicylate, the calcium salt of aspirin, phenobarbitone and barbitone. The results obtained are shown in the accompanying table.

It is interesting to observe the peculiar effect of aspirin. When pure acetylsalicylic acid is added in requisite amount, the infusoria show perfect evidence of narcosis; but they appear to be killed at the same time, since on transferring to fresh water they show no signs of recovery. If the aspirin be converted into calcium acetylsalicylate and employed at pH 6·0, the narcotized Rotifera recover when transferred to fresh water. If the calcium salt be decomposed by the addition of acetic acid, so that the pH value is about 3·5, then no recovery takes place. Since salicylic acid appears to be fairly lethal and the Rotifera do not recover from treatment with a dilution of 1 : 1,500, it would seem that the peculiar effect of aspirin may be connected with the breakdown of the molecule into its component moieties. So far as is known, aspirin decomposes in aqueous solution of pH 3·3 at 20° C., at the rate of about 1 per cent per hour, a speed which is too slow to account for the rapidity of kill. It may be, however, that the acetylsalicylic acid is decomposed at a much greater rate when it is in the internal fluid of the Rotifera and where *in vivo* factors are operating.

Compound	Concentration of drug producing		Recovery from narcosis
	Kill	Narcosis	
(1) *Analgesics* :			
Hyoscine hydrobromide	1 : 200	1 : 1,500	+
Amidopyrine	1 : 1,000	1 : 40,000	+
Aspirin	1 : 1,000	1 : 2,000	–
Calcium aspirin (pH 3·5)	1 : 200	1 : 450	–
Calcium aspirin (pH 6·0)	1 : 40	1 : 70	+
Salicylic acid	1 : 1,000	1 : 1,500	–
Sodium salicylate (pH 6·4)	1 : 20	N.N.	–
Phenacetin	1 : 1,500	1 : 2,000	+
(2) *Local Anæsthetics* :			
Cocaine hydrochloride	N.K.	1 : 7,000	+
(3) *Anæsthetics* :			
Ethyl alcohol	1 : 10	1 : 10	
Chloroform	1 : 500	1 : 1,600	+
(4) *Hypnotics* :			
Morphine	1 : 400	1 : 500	
Codeine	1 : 30	N.N.	–
Barbitone (pH 9·2)	1 : 20	N.N.	–
Phenobarbitone (pH 9·0)	1 : 14	N.N.	–

N.K.: up to a concentration of 1 : 750, cocaine did not kill.

N.N.: narcosis could not be produced by sodium salicylate nor with the hypnotics codeine, barbitone or phenobarbitone. With morphine, some 60 per cent of the Rotifera showed evidence of narcosis, while with ethyl alcohol at a concentration of 1 : 10 less than 50 per cent were narcotized, the remainder being killed.

We have found that the larger animalcules, such as *Cyclops* and *Daphnia*, do not lend themselves to this type of experimentation. The experimental results suggest, however, that the Rotifera are excellent experimental animals for the assay of drugs which have analgesic and anæsthetic properties.

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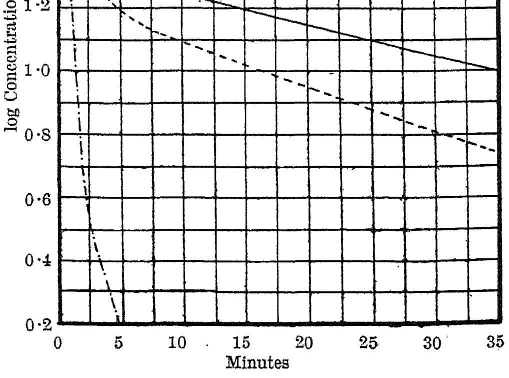
Fœtal Hæmoglobin and Erythroblastosis

In a recent communication, Jonxis[1] reports quantitative estimations of alkali-resistant and labile hæmoglobin in cases of hæmolytic disease of the new-born. He comes to the conclusion that after birth only hæmoglobin of the labile, adult type is formed, and that in hæmolytic disease of the new-born there is a selective destruction of red blood corpuscles containing fœtal hæmoglobin. We carried out in the years 1939–42 a great number of similar estimations; these have been briefly reported previously elsewhere[2,3].

Our results were at variance with those of Jonxis. The method applied was a modification of that of Haurowitz[4], adapted to the use of Evelyn's photoelectric step-photometer. The investigations were carried out before the *Rh* factor and its relationship to the hæmolytic disease of the new-born was known, and it is significant that the study of denaturation curves after blood transfusions revealed two types, one indicating a selective destruction of the baby's cells and one showing indiscriminate destruction. In the accompanying figure the abscissa represents the time in minutes after addition of $N/4$ sodium hydroxide, the ordinate the logarithms of the concentration of oxyhæmoglobin at each time. The concentration of the original solution, which was always approximately 0·1 gm. per 100 ml., was taken as 100. The percentage of alkali-resistant hæmoglobin was calculated by extrapolation of the second, gentle slope to time 0. The case was that of a hæmolytic disease of the new-born and had a high reticulocyte count indicating a rapid regeneration of erythrocytes. The graph shows a complete replacement of the fœtal hæmoglobin by the adult type after blood transfusion, and yet 24 hours later there is already 16·5 per cent alkali-resistant hæmoglobin. Further curves illustrating selective and indiscriminate destruction of erythrocytes after blood transfusions in cases of hæmolytic disease of the new-born are given in an earlier publication[3].

Where a few days after a blood transfusion the denaturation curve returns to the pre-transfusion type in the presence of a high destruction- and



regeneration-rate, it is obvious that fœtal hæmoglobin has been formed in extra-uterine life. Cases with an indiscriminate destruction of patient's and donor's cells show that there is no relationship whatever to the type of hæmoglobin present in the red blood corpuscles. In full agreement with these findings are the results obtained by Mollison[5], who studied the survival of transfused erythrocytes in hæmolytic disease of the new-born by the method of differential agglutination. In almost all cases where *Rh*-positive red blood cells have been transfused they were eliminated within ten days. The destruction of erythrocytes in hæmolytic disease of the new-born depends on their sensitization by *Rh* antibodies and shows no relationship to the chemical constitution of the globin component of their chromoprotein.

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Carbonic Anhydrase in *Arenicola marina*

Several years ago, Brinkman and his collaborators reported that carbonic anhydrase is present in the blood of *Arenicola*[1]. This observation was confirmed by Florkin[2]. Recently, through the kindness of Prof. H. Munro Fox, I have had an opportunity of studying the distribution of the enzyme in this annelid in more detail than was done in these two papers, and some interesting points have come to light.

The determinations of enzyme activity were made by the 'boat' method of Meldrum and Roughton[3], precautions being taken to ensure that diffusion did not constitute a limiting factor. All the experiments were carried out at 0° C., the Meldrum – Roughton unit of activity being calculated for that temperature. Tissues were cut into small pieces, washed with several changes of sea water and then weighed. After being ground with a little sand, they were extracted for one hour at room temperature with distilled water in the proportion of 1 ml. to each 25 mgm. of tissue. The catalytic effect of the tissue extracts was always compared with the activity of blood diluted to give the same final hæmoglobin concentration. Hence any errors due to traces of blood remaining in the tissues were reduced to a minimum. Hæmoglobin was determined directly with a Hilger – Nutting spectrophotometer.

Table 1 gives the figures obtained for blood samples taken from five individuals, together with figures for human blood (A. M. C.) to serve as a comparison. It will be seen that the mean activity of *Arenicola* blood is about the same as that of human blood, although there is considerable individual variation.

Table 1

Enzyme (units per c.mm.)	Hæmoglobin (gm. %)	Activity : hæmoglobin
4·0	2·9	1·38
3·6	3·5	1·03
4·5	4·1	1·10
3·4	2·6	1·31
2·6	1·8	1·44
Mean : 3·6	Mean : 3·0	Mean : 1·25
3·7 (A. M. C.)	15·3	0·024

The ratio of enzyme activity to hæmoglobin concentration, calculated as units of enzyme per cubic millimetre of blood and grams of hæmoglobin per hundred c.c., is much higher in *Arenicola* than in human blood and tends to be fairly constant. The presence of such a large amount of carbonic anhydrase is of considerable importance, for *Arenicola* blood, like that of most annelids, contains very few corpuscles. Of four samples of blood centrifuged for thirty minutes at 3,200 r.p.m., only one showed any signs of a slight deposit of cellular material. Thus the enzyme must be free in solution, an exception to the generalization that carbonic anhydrase is never found outside cells[4].

The enzyme is also present in appreciable amounts in many of the tissues of *Arenicola* (Table 2) but is absent from the cœlomic fluid, as was noted by Florkin.

Table 2

Tissue	Units of enzyme per 50 mgm. wet weight
Œsophageal pouches	71–110
Chlorogenous tissue of stomach	15–38
Gills	5–15
Œsophagus	6–14
Nephridia	3–12
Intestine	1–4
Ep dermis	1–3
Muscles	Traces
Proboscis	Traces
Nerve cord	Nil
Cœlomic fluid	Nil

Of all the tissues examined, the œsophageal pouches showed the highest concentration of carbonic anhydrase. Although these diverticula have a very rich blood supply from several large sinuses situated beneath the inner epithelial lining, it seems rather improbable that they play an important part in the direct elimination of respiratory carbon dioxide from an animal so well equipped with external gills as *Arenicola*. On the other hand, it is difficult to see what other function they could have. The secretion is only slightly acid (*p*H about 6·4), so the glands can scarcely be similar to the gastric glands of vertebrates. It might be worth while considering whether the pouches represent a primitive respiratory organ which was of importance in annelids lacking external gills. In this connexion it is interesting to recall the work of Eisig[5] on some of the smaller polychætes. He made a careful study of the œsophageal diverticula in syllids and hesionids and concluded that they act as reservoirs of water and air, from which oxygen can be obtained when the supply from the external medium is insufficient to meet the organism's requirements. Eisig compared the pouches with the swim bladder of a fish. It would be interesting to examine the catalytic activity of the tissues of *Arenicola assimilis*, a form which possesses several pairs of œsophageal pouches.

This investigation is being carried out during the tenure of an 1851 Exhibition Science Research Scholarship. My thanks are due to Prof. D. Keilin for suggesting the problem and for his interest in its progress.

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April 22.

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LOCALIZATION OF ALKALINE PHOSPHATASE IN YEAST

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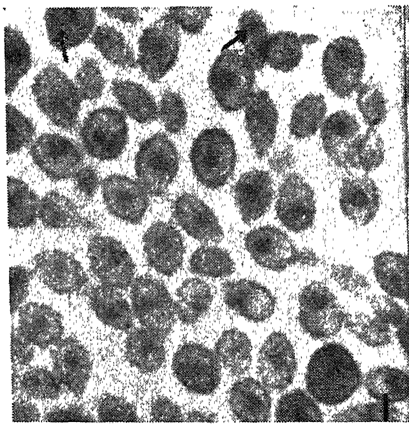
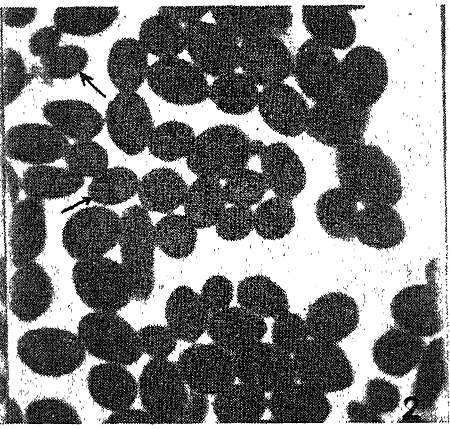
THE Gomori technique[1] for alkaline phosphatase localization has been extensively employed with animal and plant material; but it does not appear to have been employed with yeasts. The presence of acid and alkaline phosphatases in yeasts is well known[2,3,4]; but the location of these enzymes in the cell has not previously been described. We have applied the Gomori technique to preparations of *Saccharomyces cerevisiœ* (strain 'Yeast foam', Carlsberg No. 237). Cells were grown in pure culture in 10 ml. of 8 per cent Pilsner wort in Freudenreich flasks at 25° C. for 24 hr. At the end of this time the medium was poured off and 10 ml. of sterilized distilled water was added to the cells sedimented at the bottom of the flask. The cells were suspended in the water by shaking, and drops of the suspension placed on microscope slides. The cells were allowed to dry in air for 10–30 min. and then incubated in one of the several phosphate compound substrates in a veronal buffer solution containing magnesium and calcium at pH 9·2 for 16–40 hr. at 37° C. The cobalt sulphide method of staining[1] was then applied.

Under these conditions we found phosphatase reactivity was shown by a general darkening, and also by more intense localization as a dark spot within the cell (Fig. 1). This spot localization was obtained with hexose diphosphate, sodium glycerophosphate, and sodium pyrophosphate as substrates. With sodium hexametaphosphate as substrate, the spot did not appear; but the reaction resulted in a more intense general darkening and in the appearance of some granules, located in the peripheral layers (see Fig. 2). No spot or darkening was obtained in the controls (no substrate) or after heating the cells (for 3 min. in boiling water). Fig. 3 shows the negative reaction after heating. In the absence of magnesium, there was some decrease in activity detectable with sodium glycerophosphate and hexose diphosphate, and almost no activity with sodium pyrophosphate or sodium hexametaphosphate as substrates.

Concerning the spot localization, there is some independent evidence that such a structure exists as a morphological entity. This evidence was obtained by use of the Feulgen stain (Feulgen-positive body observed in an approximately similar position) and by observation of living cells in the phase-contrast microscope. It is not unlikely that this spot can be interpreted as the nucleus of the yeast cell. The body observed by us agrees well with the cytological picture of the yeast nucleus as presented by Nagel[5]. She demonstrated in the yeast cell the presence of two distinct bodies which she labelled 'parvicorp' (nucleus of most earlier authors) and 'companion body'. We have also encountered a structure comparable to the 'companion body'. This was a smaller and lighter area adjacent to the darker area of the spot. With hexose diphosphate, sodium glycerophosphate, and sodium pyrophosphate, it seems that alkaline phosphatase activity is localized with a Feulgen-positive structure and thus may be associated with desoxyribose nucleic acid. (However, ribose nucleic acid may also be present.) This finding of phosphatase within the Feulgen-positive material is in accord with those for the localization of alkaline phosphatase activity on the salivary gland chromosomes of *Drosophila*[6,7], and for the general association of phosphatase activity with desoxyribose nucleic acid as discussed by Jeener[8].

The general darkening within the cell suggests a possible association of enzyme activity with ribose nucleic acid. Such an association has been described previously for other tissues[9]. We treated cells with ribonuclease (10 mgm. per cent) as employed by Brachet[10] and Brachet and Jeener[11] for the removal of ribose nucleic acid from the yeast cells. The reagent was used as an aqueous solution on washed air-dried films of cells. Yeast cells were allowed to remain in contact with the enzyme solutions at





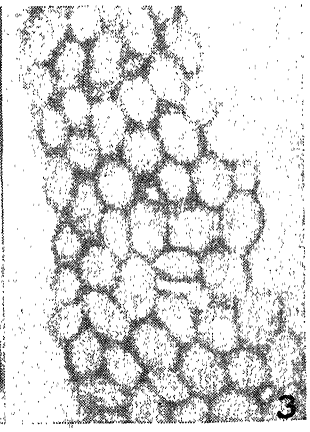


Fig. 1. Yeast cells exhibiting dark precipitate obtained by the Gomori phosphatase reaction using pyrophosphate as a substrate. Magnification, × 900; arrows to 'companion body'

Fig. 2. Yeast cells after the Gomori phosphatase reaction using hexametaphosphate as substrate. Magnification, × 900; arrows to cells with peripheral granules

Fig. 3. Yeast cells heated for 3 min. before incubation with pyrophosphate as substrate. Magnification, × 900

20° C. and 35° C. for several hours, during which time samples were taken at intervals and examined for phosphatase activity with each substrate. There was a decrease in the general darkening; but a shrinkage of the cytoplasm within the cell made cytological evaluation very difficult. The usual homogeneous dark Gram staining reaction of yeast thus treated with ribonuclease was reduced to stippled surface areas, and a fair proportion of the cells were Gram-negative. Henry and Stacey[12] have shown that the property of Gram positivity is associated with surface magnesium ribonucleate. This might be interpreted as indicating that in addition to the Feulgen-positive localization some alkaline phosphatase in yeast may also be associated with ribonucleic acid at the cell surface. Recent investigations[13] on P^{32} exchange by yeast implicate a surface nucleic acid – riboflavin complex in the uptake of inorganic phosphate by cells from the medium. Furthermore, Brachet and Jeener[14] and Chantrenne[15] have established that sedimentable cytoplasmic granules in mammalian cells comprise an association of ribonucleic acid, phosphatase, and other enzymes. Brachet[16] and Krugelis[17] find that there is a correlation between the localization of ribonucleic acid and alkaline phosphatase activity in the developing embryo of amphibians. The surface darkening and the granulation obtained with hexametaphosphate suggest the possibility of another enzymatic reaction, although we are aware of the protein precipitant nature of metaphosphate and the possibility of an artefact being produced during the reaction. The dependency on magnesium ion and heat lability of this reaction are in favour of its being enzymatic; with this substrate we have also used a reaction temperature of 20° C. in view of the apparent instability of the hexametaphosphate under our conditions at 37° C. This reaction with metaphosphate, if enzymatic, may be involved with ribose nucleic acid, since Macfarlane[18] has isolated metaphosphate from yeast as an iron – nucleic acid complex.

One more line of evidence points to the association suggested above of nucleic acid and alkaline phosphatase in yeasts. Cells raised in a medium deficient in magnesium ions were stated by Henry and Stacey[12] to exhibit greatly reduced Gram positivity. We grew yeast in a synthetic medium with known low concentrations of magnesium and ferrous ions (medium first purified by 8-hydroxyquinoline-chloroform extraction following Waring and Werkman[19] and the ions afterwards added). Cells grown in this medium exhibited the lessened Gram staining properties described above and showed a reduced darkening of the phosphatase reaction, accompanied by obvious changes in the general morphology of the cell.

The positive cytochemical reaction obtained with pyrophosphate and the monophosphate esters as substrates suggests the presence of two enzymes (a pyrophosphatase and a phosphomonoesterase) localized in the spot or nucleus of the yeast cell and present more diffusely in the cytoplasm as well. The extreme dependency of the pyrophosphatase activity on magnesium ions as contrasted with a lesser dependency of the phosphomonoesterase activity strengthens the contention that two different enzymes may be present. The literature contains convincing chemical evidence[20,21,22] for the existence of a pyrophosphatase distinct from a phosphomonoesterase, although the two are often associated together in a variety of plant forms. The appearance of a somewhat different localization of the reaction with hexametaphosphate as substrate may mean a third enzyme, for which there is some evidence from the work of Schäffner and Krumey[2].

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APPLICATION OF DYNAMIC SIMILARITY TO METAL STRUCTURES WITH ELASTIC AND PLASTIC FLOW

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In the attempt to attain dynamic similarity for fluid flow systems, different dimensionless criteria appear according to whether momentum and viscosity, or momentum and gravity, are the dominant factors in deciding the flow pattern. The purpose of this communication is to show that a similar argument applied to the attempt to attain dynamic similarity for the flow of a metal structure gives also two alternative dimensionless criteria according to whether momentum and elasticity or elasticity and plasticity are the dominant factors.

For the purpose of dimensional analysis, it is sufficient to consider one dimensional movement, and the fundamental equation governing the motion of an element of the metal structure can be written in the simplified form

$$m \, . \, \frac{\partial v}{\partial t} = P_x + \frac{\partial}{\partial x}\left\{f\left(\varepsilon, \frac{d\varepsilon}{dt}, \int_{\theta=\infty}^{\theta=t} K(t-\theta) \, . \, \sigma(\theta) \, . \, d\theta\right)\right\}, \tag{1}$$

where m is mass of metal per unit length (gm./cm.); v is velocity of movement of volume element (this is related to ε, but it is not necessary to express the relation for the purposes of dimensional analysis) (cm./sec).; P_x is external force acting on unit length of metal (dynes/cm.^{2}); ε is normal strain (dimensionless); θ is parameter expressing the previous time at which a stress $\sigma(\theta)$ was applied (sec.); $K(t)$ is 'remembrance function' expressing the effect upon the present strength of previous application of stress[1].

The expression in the bracket on the right-hand side represents the difference between the stress acting upon the element of volume and the internal forces (elastic and plastic) resisting this stress. Its exact form is open to doubt; as expressed here it is equivalent to the assumption that these internal forces depend on the extent of the deformation, the rate of the deformation and on previous history. Orowan[2] has pointed out that even an equation of this form cannot express fully the behaviour of a metal, since it is possible to wipe out the entire influence of the past by a sudden extension of a few per cent. Even this statement implies, however, that the past history affects the present strength in a definite way although difficult to express mathematically. It is possible, therefore, for dimensional purposes to write equation (1) in the form

$$m\frac{dv}{dt} = P_x + \frac{d}{dx}\left\{E\varepsilon + \eta\dot{\varepsilon}\right\}, \qquad (2)$$

where both E (the instantaneous value of Young's modulus) and η (the instantaneous 'viscosity') are to be regarded as complex but definite functions of past history, having the dimensions of dynes/cm.^{2} and dyne-sec./cm.^{2} respectively.

When dimensional analysis is applied to equation (2), the condition for static similarity is the usual one; $N_1 = P/E$ must be the same in model and original, so that the forces per unit area in model and original must be the same if the same material is used (same value of E).

In flow systems where the inertia of the material itself and the elastic forces are the important factors, for example, in elastic oscillations of a clamped bar or in impact testing, the condition for dynamic similarity is that

$$N_2 = \rho\,\frac{V}{T}\Big/\frac{E}{L} = \frac{\rho}{E}\cdot V^2 \text{ or } \frac{\rho}{e}\cdot\frac{L^2}{T^2}.$$

Hence when the same material is used in model and original, the usual similarity condition applies, that velocities must be kept constant, that is, the time-scale must be shortened in proportion to the reduction of linear dimensions.

Where, however, plastic or viscous forces are important as well as elastic forces but the inertia of the material can be neglected, a different criterion for dynamic similarity appears. In general, it is now essential to use the same material for model as for original, and it then follows that the condition for similarity is that *the time-scale is the same in the model as in the original.* It follows that it is not possible to obtain dynamic similarity on a reduced scale where both inertial and rate-dependent plastic forces are important.

In the general case it is not possible to construct a suitable dimensionless criterion for this condition —if a Kelvin solid[3] could be found for which E and η of equation (2) were definite fixed quantities one could define a Kelvin Number:

$$N_K = \frac{\eta}{T}\Big/E = \frac{\eta}{E.T}.$$

The condition of equality of time-scale implies that the material of the model has been carried through the same past treatment of stress and heating on the same time-scale as the material of the original. The fundamental assumptions on which similarity is based when this condition is satisfied are those implied in the presentation of most experimental data on the engineering properties of metals, namely, (1) σ and ε are connected in the same way for specimens of different sizes; (2) if the metal is subjected to the same treatment over the same length of time its internal condition is changed in the same way; to which must be added the condition which separates the use of K_K from N_2; (3) the inertial forces must be negligible compared with the rheological ones.

These three conditions enable the limits of applicability of the plastic criterion of dynamic similarity to be defined as in the case of the R_e and F_r criteria for fluid flow. Brittle fracture[4] and fatigue do not satisfy the first condition because there is an absolute scale of size inherent in each of these processes, so that no similarity is possible with scale change. Fibrous fracture may in some cases not satisfy the third condition and impact testing certainly does not. On the other hand, most cases of creep, internal damping, rate of loading effects, elastic after-effect, and plastic flow in the work-hardening range satisfy the three conditions. In such cases similarity can be attained even though external forces are of the impact type, provided the latter are suitably scaled as L^2. Similarly, in studying the effect of self-oscillations of a structure upon permanent set, external loading of the model structure to give the same period of oscillation satisfies the conditions. The reproduction of joints in a structure on the model scale necessarily gives rise to failures of similarity[5], which makes unsuitable the use of models of systems where the flow primarily takes place at joints.

This similarity criterion is very much easier to satisfy than that of the Reynolds number, where the use of the same material implies that the time-scale must be shortened by n^2 if the length-scale is reduced by $1/n$; and may therefore have useful applications in connexion with the laboratory study of rate of loading and damping effects in such structures as wire ropes, ship or car hulls and girders.

[1] Zener, C., *Metals Technology*, 23 (Aug. 1946).

[2] Orowan, E. (private communication).

[3] Reiner, M., "Ten Lectures on Theoretical Rheology", Equation 16 (1946).

[4] Orowan, E., Fracture and Notch Brittleness in Ductile Materials. Brit. Iron and Steel Res. Assoc. Conf. at Cambridge, 69 (Oct. 1945).

[5] Baker, J. F. (private communication).

CHOLINESTERASES

By Dr. KLAS-BERTIL AUGUSTINSSON

Biochemical Institute, University of Stockholm

It is known that the cholinesterases from various animal tissues are not identical, and it has been proposed that two types of acetylcholine-splitting enzymes exist. This 'type theory' does not explain fully some of my recent observations[1].

Substrate specificity depends probably on the protein character of the enzyme molecule, which may vary from tissue to tissue. In blood serum, the enzyme is probably an albumin; in the red blood cells, where it has been shown to be bound to the cell membrane, it is probably a lipoprotein. This is also true for the cholinesterase of the nervous system, where the enzyme is bound to the cell structure. Hence, the red-cell esterase would be expected to be related to the nerve esterase rather than the serum esterase, and this has, in fact, been demonstrated. The enzymes from brain and red cells are said to be 'specific' cholinesterases, and in addition a 'non-specific' cholinesterase is said to exist, for example, in human serum, which hydrolyses acetylcholine as well as aliphatic esters, for example, tributyrin.

The use of acetyl-β-methylcholine and benzoylcholine for distinguishing between these two types of cholinesterase may sometimes be of value, but it is not sufficient for a classification of these enzymes. In comparing the activities of an esterase towards various esters, the substrate concentrations must be considered. For example, the 'specific' cholinesterase splits both acetyl-β-methylcholine and acetylsalicylcholine at a lower rate than acetylcholine at low substrate concentrations, but at a higher rate when substrate concentrations are high. Bodansky[2] has shown that the red-cell esterase acts on triacetin, and I find that this enzyme hydrolyses the acetyl-ester linkage in acetylsalicylcholine; the term 'specific' is therefore not adequate.

In agreement with Richter and Croft[3] and with Bodansky[2], I regard the cholinesterases as a 'family' of related enzymes with widely divergent properties. The following classification is based on the activity-substrate concentration relationship for acetylcholine as substrate. This classification leads me to distinguish two groups. Group I contains enzymes which are inhibited at high concentrations of acetylcholine (optimum at 3×10^{-3} *M*). The enzymes of Group II follow the Michaelis – Menten formulation, which means that the maximum rate occurs with infinite substrate concentrations. Enzymes within each group differ in certain other respects. There is no absolute specificity to choline esters in either group.

Group I includes the cholinesterases of the nervous system, of red blood cells, of *Helix* blood and of *Sepia* 'liver'. The red-cell and brain esterases are identical, but differ from the *Helix*-blood and *Sepia*-'liver' esterases. Differences are seen in the action of inhibitors such as choline, caffeine and quinine, and in the ability to split various esters. For example, the *Helix*-blood esterase is characterized by its high activity with acetylaneurine as substrate. The cholinesterase of shark plasma also belongs to this group.

Group II includes the cholinesterases of certain sera (for example, man, horse) and of the dart sac of *Helix pomatia*. The serum esterases show inhibition by excess of benzoylcholine (optimum concentration $1{\cdot}0 \times 10^{-2}$ *M*); this is not the case with the dart-sac esterase, which hydrolyses benzoylcholine rather slowly. The serum esterases are competitively inhibited by choline, but not the dart-sac esterase.

Acetylcholine is the only choline ester found in animal tissues, and this is why I define as a cholinesterase an esterase which, under conditions optimal for the hydrolysis of acetylcholine, splits this ester more rapidly than any other ester. Consequently the rapid hydrolysis of benzoylcholine by guinea pig liver is not due to a cholinesterase; this reaction is not due to specific 'benzoyl-choline esterase'.

The optimum substrate concentration is increased in the presence of the strongly basic clupein. The negatively charged gum arabic is known to have the opposite effect[4]. I was unable to confirm the finding of Mendel and Rudney[5] that the addition of potassium chloride caused a shift of the optimum substrate concentration. The affinity of the positively charged acetylcholine ion for cholinesterase may be directly proportional to the negative charge of the enzyme. Hence, with increasing negativity, optimum conditions are shifted towards lower acetylcholine concentrations, that is, towards more physiological conditions. I am inclined to think that such a change in cholinesterase activity occurs during nervous activity. In depolarization, the neuronal surface becomes more negative, and since cholinesterase is concentrated at this surface[6], enzymic activity becomes optimal at lower concentrations of acetylcholine.

[1] Augustinsson, K. B., *Acta physiol. Scand.*, **15**, Supp. 52 (1948).
[2] Bodansky, O., *Ann. N.Y. Acad. Sci*, **47**, 521 (1946).
[3] Richter, D., and Croft, P. G., *Biochem. J.*, **36**, 746 (1942).
[4] Mendel, B., and Rudney, H., *Science*, **100**, 499 (1944).
[5] Mendel, B., and Rudney, H., *Science*, **102**, 616 (1945).
[6] Nachmansohn, D., "Vitamins and Hormones", **3**, 337 (1945).

CLAY MINERALS AS CATALYSTS AND ADSORBENTS

A WHOLE-DAY meeting of the Clay Minerals Group of the Mineralogical Society, held in the apartments of the Geological Society on January 23, was largely devoted to a discussion on the use of clay minerals as catalysts and industrial adsorbents; in the later part of the afternoon some general papers were also given.

Mr. R. H. S. Robertson (Glasgow) introduced the subject with a highly condensed account of the catalytic uses of clays, which could not adequately be summarized. He pointed out that so long ago as 1915, Gurwitsh studied the catalytic polymerization of unsaturated compounds by floridin, and this clay (the active element in which is attapulgite) has since been used in a wide variety of other reactions. Another clay about which much data are available is Japanese acid clay (montmorillonitic). Every type of organic reaction has been shown to be catalysed by one or other of the available types of clay.

Dr. F. E. Salt (Distillers' Co., Ltd.) described experiments on polymerization of α-methyl-styrene. This substance is not polymerized by heat alone, as styrene is; but in the presence of suitable clays it reacts at a low temperature to give low molecular weight polymers ('Polymeth') which may find uses as plasticizers or extenders, or (when mixed with castor oil) as microscope immersion media. The clays used were activated montmorillonites of German and English origin. In the discussion, Mr. Armitage (Lewis Berger and Sons) mentioned the use of such clays for polymerizing indene, coumarone and styrene.

An account of the uses of clays in cracking petroleum was given by Mr. J. N. Haresnape (Anglo-Iranian Oil Co.). Here again, activated montmorillonites are used, and they have to compete with the more effective, but more expensive, artificial products (silica–alumina gels), which were largely used during the War, when cost was a secondary consideration. The clay catalysts tend to alter during use, with production of excessive gas and carbon. This has been attributed to hydrogen sulphide adsorption, though the Anglo-Iranian workers have found that clays of high iron content show this type of activity even with low-sulphur feedstocks.

In practical operations with clay catalysts, difficulty arises from the very large quantity of catalyst which has to be put through a cycle of use and regeneration by heat. One successful practical method of doing this is the fluidizing technique, which was described by Dr. T. H. Blakeley (Esso Development Co., Ltd.), and illustrated by a film and demonstration. In this method small granules (20–40 μ) of catalyst are agitated by an upward stream of oil vapour, in which state they show many of the properties of a liquid, and may be dealt with in a continuous process. Plants working on this principle which are in use or on order (excluding the U.S.S.R.) are capable of dealing with 60,000,000 tons of feedstock per year.

In a discussion on the process of activation of montmorillonites, Dr. B. S. Emödi (Fullers' Earth Union, Ltd.) explained that, by means of acid treatment, the crystalline structure appears to be partly broken down. The improved catalytic activity may be associated with the presence of free colloidal silica, or with the greater effective surface of the mineral, or with both factors.

The afternoon session contained papers on topics connected with adsorption. It was opened by Mr. A. Ibison (W. Bibby and Sons, Ltd.), who dealt with the adsorption of colours from oils and solvents. He stressed the importance of fixed conditions of temperature, moisture, acidity, etc. Adsorption isotherms, corresponding to maximum percentage colour adsorbed at each colour concentration, are then found to be of the Langmuir type with non-activated clays, and steeper with the activated type.

Dr. G. W. Nederbragt (Bataavsch Petroleum Mij, Amsterdam) described the use of floridin for separating long-chain from branched-chain hydrocarbons. The technique used is essentially that of chromatographic analysis with pentane as the solvent. The author suggested that the selective adsorption of normal hydrocarbons is due to the channels present in the structure, as described by Bradley[1].

Experiments on the adsorption of basic dyes by calcium montmorillonite were described by Dr. Emödi. It was observed that while the dye adsorbed is nearly equivalent to the base-exchange capacity of the clay (104 m. equiv. per 100 gm.), usually only 30–80 m. equiv. of calcium are released, the discrepancy increasing with the number of benzene rings in the molecule. From calculations of the frequency of calcium ions between the montmorillonite sheets and the area of the dye molecules, the theory was advanced that the latter are adsorbed between the unit plates, but mainly near the edges, thus blocking the outlet of many exchangeable calcium ions. The clay particles thus become positively charged and can adsorb negative ions.

Dr. D. M. C. MacEwan (Rothamsted Experimental Station) suggested that the mechanism of formation of organic complexes by montmorillonite may be closely connected with surface adsorption on such minerals as mica, the tendency of the clay mineral sheets to gather one or more adsorbed layers of molecules providing a repulsive force between them, while the balancing attractive force may be electrostatic in nature. Using Bangham's data[2] on mica adsorption, it is possible to get a potential curve for methanol showing a minimum in the right position.

Two general papers, descriptive of work done under a programme of research for the British Iron and Steel Research Association, were given by Dr. J. White and collaborators of the University of Sheffield. The substance of the paper by B. Vassiliou has already appeared in *Nature*[3]. The second (with P. Murray) dealt with an attempt to measure reaction constants and activation energies for the thermal dissociation of structural water in different types of clay, using both constant and steadily increasing heating rates. Good results were obtained with kaolinitic and micaceous clays enabling the form of thermal analysis peaks to be reproduced from the calculated data; but with a montmorillonitic clay the values obtained for the constants depended on the conditions of heating, a point which is now being investigated.

Comparison of the papers given in the morning and afternoon sessions suggested that phenomena of adsorption tend to be better correlated with what is known of the clay mineral structures than those of catalysis. Meetings such as this should therefore serve a useful purpose by bringing together clay mineralogists with chemists working on the problem of catalysis, and enabling them to exchange information.

D. M. C. MacEwan

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[1] Bradley, W. F., *Amer. Min.*, **25**, 405 (1940).

[2] Bangham, D. H., and Mosallam, S., *Proc. Roy. Soc.*, A, **166**, 558 (1938).

[3] Vassiliou, B., and White, J., *Nature*, **161**, 487 (1948).

ELM DISEASE

ELM disease has been a serious pest in Britain during the last score of years. The Forestry Commission has issued Leaflet No. 19 (London: H.M. Stationery Office, 1947), which is an up-to-date account of what is known at present about this disease, the life-histories of the associated bark beetles, and control measures.

The attack in most parts of England and Wales is by now pretty well known, and the trees either die down from the top, or they may die from the top down one side. Usually the cause of the die-back is the fungus *Ceratostomella ulmi* Buism. working in association with *Scolytus* elm bark beetles. When this disease was first discussed, it was known as the Dutch elm disease, having come into Britain from, it was thought, Holland. Its connexion at that time with the bark beetle was not generally appreciated. The fungus is a member of the *Ascomycetes*. It exists in the tree mainly in the form of small yeast-like bodies, which multiply rapidly by budding, and are carried along in the water-conducting vessels with the sap. The fungus produces a toxic substance, which not only poisons the affected branch, but also stimulates the vessel walls to produce gum-containing bodies. These tend to block the vessels and thus lead to death from lack of water, as well as from direct poisoning.

As is well known, bark beetles are especially dangerous to a tree when anything has occurred to stop or to lessen the upward flow of sap. In the case of elm disease, when the sap flow becomes restricted, the well-known elm bark beetles, *Scolytus scolytus* (*destructor*) and *Scolytus multistriatus*, can make their breeding grounds in the bark with comparative ease. The grubs hatching from the eggs thus have a cambium layer, with a restricted flow of sap but sufficient to keep it fresh, upon which they feed.

The fungus can only produce its minute and delicate fructifications in very sheltered situations, such as under loosened bark or in the beetle galleries. The fructifications are of two kinds, black flask-shaped bodies (asci) and thin black stalks (coremia); both are about 1 mm. in length, and both bear microscopic spores at the top in round drops of mucilage. Although they are visible to the naked eye when produced in mass, they are hard to find, and of little value, therefore, in early diagnosis.

Ceratostomella ulmi is not the only cause of disease in elms; but in the south of England, at any rate, it outweighs all other diseases in importance. In Scotland the wych elm is subject to a dieback less rapid and usually less severe than that caused by true elm disease; the cause is as yet unexplained. Elms in towns may be killed by gas leakages, and those in unfavourable situations are often injured by drought or excessive water in the soil; but these causes of death are easily distinguished from the elm disease proper.

Bull. 841, Cornell University Agricultural Experiment Station (September 1947) also deals with elm disease; it is entitled "Log Treatments for Bark Beetle Control in connection with the Dutch Elm Disease". The bulletin is devoted to the assembly of the principal data from a series of long-treatment experiments carried out at the Dutch elm disease research laboratory of the New York State College of Agriculture. The War stopped a number of the experiments which were in hand, and others which had been planned were not begun. It was therefore decided to publish all the results of the work so far carried on, so that this information might be available for the continuation of research, and the determination of control programmes.

The fungus is the same as that mentioned above, but the beetles working in conjunction with the fungus in the United States are *Scolytus multistriatus* and *Hylurgopinus rufipes*. The disease organism is described as harbouring in bark beetle galleries made in wood from healthy trees, as well as from diseased trees, and is carried out and distributed by the beetles which emerge. The proper disposal of dead and dying elm wood which is suitable for bark beetle breeding, even if it is not from diseased trees, is therefore an essential feature of a local Dutch elm disease programme.

It is not possible to deal more closely with the contents of this most interesting bulletin, which is well worth studying, with its interesting illustrations. It is, however, a matter of considerable interest that the so-called Dutch elm disease has now become very widespread, and it certainly requires intensive investigation. The present writer has himself been watching infested trees of his own during the past twenty years, and as one outcome of the observations carried out, considers it does not follow that a tree attacked will die, for it may throw off the disease. In this there is possibly some connexion between the vigorous state of the tree, and the fact that the *Scolytus* beetles do not get the upper hand; in fact, quite possibly they are unable to make their breeding galleries, owing to the flow of sap being too strong. E. P. STEBBING

NATIONAL INSTITUTE OF ECONOMIC AND SOCIAL RESEARCH

THE annual report of the National Institute of Economic and Social Research for 1946–47 records no change in the financial situation; grants from the Rockefeller Foundation, the Leverhulme Trustees and the Nuffield Foundation continuing to be the mainstay of the Institute's finances, and a special grant of £1,000 was made by the Nuffield Foundation for the support of a book to be published under the title "Lessons of the British War Economy", which is intended to form a professional symposium on British war economics. With funds of the Garton Foundation, transferred to the Institute in 1942, it has been decided to establish an annual Garton Prize, probably of the value of 100 guineas, which was to be offered for competition in 1948. It is intended to publish the prize-winning essay in a special Garton Monograph Series. Experience with the Senior Research Fellowship scheme which terminated during the year showed the value of the scheme in assisting university research during the transition period; but the increased funds becoming available for research in the social sciences in the universities of Great Britain have diminished the need for special awards for experienced research workers, and there is already difficulty in finding persons of sufficient maturity and experience for the programmes planned.

A grant was made to Bedford College in support of the research project entitled "An Enquiry into the Social Factors Determining Earned Income" being carried out by Mrs. Barbara Wootton, another to the Department of Applied Economics, University of Cambridge, for a senior research worker for the output section of the inquiry into expenditure, output and income, 1920–38, and another to provide Prof. E. Victor Morgan, at University College, Swansea, with part-time research assistance for the project "Studies in British Financial Policy, 1914–25". It was expected that the report of the Joint Advisory Sub-Committee with the Institute of Chartered Accountants on the meanings and uses of terms commonly employed by both accountants and economists would be ready for submission to the Joint Exploratory Committee early in 1948. The Institute has also agreed to co-operate in the provision of bibliographical service with the International Association for Research in Income and Wealth.

The fourth issue of the "Register of Research in the Social Sciences" was circulated in the spring of 1947, and the "Register" is in future to be published as an annual available on a subscription basis only. In regard to research programmes, the major task of fact-collecting for the "Distribution Enquiry" has been completed, and work on each of the three main parts of the "Building Enquiry" progressed steadily. Work has continued on the "National Expenditure, Output and Income, 1920–38, Enquiry", and a new investigation, to be called "The Social Accounts of Local Authorities", has developed out of work on the Public Authority section. The report on international comparisons of productivity in British and American manufacturing industry has been circulated privately to a limited number of research centres, Government departments and other organisations.

The contribution of the independent research institute is discussed at some length in the report, which points out that such organisations are the natural complement of the universities, with which, and Government departments, the report of the Clapham Committee was solely concerned. They can undertake investigations which are unlikely to be developed under university conditions, and apart from providing a common meeting-place for representatives of different interests and different approaches to the social sciences, they can take risks in opening new ground or trying expensive new methods which an individual scholar or university might not be able to afford. Among the ancillary functions of the independent research institute, special emphasis is laid upon that of providing a clearing house for information.

The Institute in March 1947 called an informal conference of some forty persons responsible for the conduct or organisation of research. As a result of this conference, a report was published entitled "Social and Economic Research and Government Departments" which has been given a wide circulation. The conclusions of the conference are embodied in a set of practical proposals which go far towards providing means for unravelling the difficulties of the research worker in the social sciences in his dependence on official sources of data. For example, the conference urged that it is a matter of first importance that general principles governing the confidential character of official material should be formulated. It also recommended that in drawing up the departmental schedules governing the preservation and destruction of records, outside experts should be consulted. Other pressing problems such as the automatic release of certain collections, the setting of time-limits to the inaccessibility of documents, the publication of material by Government departments in signed articles, the development of research bulletins and the need for outside expert advice on new collections of data were also considered by the conference ; an appendix to the report lists twenty-four major collections, tabulations and analyses of data known to exist in Government departments or which can readily be compiled and are of basic importance to research workers. The report, however, is only a first step, and the conference can be convened again when there is work for it to do.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned :

Chief Animal Husbandry Officer, Department of Agriculture and Lands, Southern Rhodesia—The Secretary, Rhodesia House, 429 Strand, London, W.C.2 (August 5).

Senior Chemists to take charge of small research teams on physical and chemical problems of coal tar and its processing, an Analyst to take charge of Analytical Department, Research Chemists to work on the constitution of coal tar and refining processes, an Intelligence Officer and Librarian to take charge of a Technical Library, etc., and Abstractors (male or female graduates in chemistry with a working knowledge of French and/or German)—The Director of Research, Coal Tar Research Association, 9 Harley Street, London, W.1 (August 7).

Research Award in the Department of Zoology—The Registrar, University College, Hull (August 7).

Assistant Lecturer (Grade III) in Geography—The Secretary, The University, Edmund Street, Birmingham 3 (August 7).

Assistant Advisory Officer in Agricultural Botany—The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh 8 (August 7).

Lecturer in Electrical Engineering—The Principal, Royal Aircraft Establishment Technical College, Farnborough, Hants (August 10).

Experimental Officer at the Forest Products Research Laboratory, Princes Risborough, to assist in research work in connexion with woodworking machinery and sawmill problems—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2206 (August 11).

Head of the Horticultural Department of the Kent Farm Institute, Sittingbourne, and a Lecturer in Horticulture and Rural Studies at the Kent Horticultural Institute, Swanley—The County Education Officer, Kent Education Committee, Springfield, Maidstone (August 14).

Research Assistant in the Department of Mining—The Registrar, The University, Sheffield (August 14).

Lecturer with special qualifications in Pure Mathematics (or Assistant Lecturer)—The Registrar, University College, Hull (August 14).

Senior Lecturer (temporary) and Lecturers (2) in Mathematics at Auckland University College, Auckland, New Zealand—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (August 15).

Lecturer in the Department of Metallurgy—The Registrar, The University, Liverpool (August 23).

Senior Lecturer in Production Engineering—The Registrar, College of Aeronautics, Cranfield, Bletchley, Bucks, endorsed 'Senior Lecturer in Production Engineering' (August 23).

Chemists (men and women) for unestablished appointments in the grades of Scientific Officer Class and Experimental Officer Class, for analytical work in connexion with atomic energy development—The Ministry of Labour and National Service, Technical and Scientific Register, K Section, York House, Kingsway, London, W.C.2, quoting F.78/48A/2 (August 24).

Engineering Inspector in the Fire Service Department of the Home Office—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2208 (August 24).

Senior Professional Officer for Ceramic and Refractory Research, Government Metallurgical Laboratory, University of the Witwatersrand, Johannesburg—The Director, Government Metallurgical Laboratory, c/o Victor Reid, South Africa House, Trafalgar Square, London, W.C.2 (August 31).

Lecturer in the Department of Pure Mathematics, University of the Witwatersrand, Johannesburg—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (August 31).

Professorship of Economic and Mining Geology in the University of Adelaide—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (August 31).

Readership in Biochemistry at the Royal Cancer Hospital—The Academic Registrar, University of London, Senate House, London, W.C.1 (September 1).

Research Fellowship and a Research Assistant in the Department of Economics of Natal University College—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (September 1).

Assistant Lecturer in the Department of Physics, University College of the West Indies, Jamaica—The Secretary, Inter-University Council for Higher Education in the Colonies, 8 Park Street, London, W.1 (September 15).

Professor of Zoology at Makerere College, Kampala, Uganda—The Secretary, Inter-University Council for Higher Education in the Colonies, 8 Park Street, London, W.1 (September 15).

Laboratory Steward in the Department of Science and Technology—The Principal, Cambridgeshire Technical College, Collier Road, Cambridge.

Lecturer in Botany, and a Demonstrator in Geology—The Registrar, University College, Exeter.

Assistant Laboratory Steward in the Department of Zoology—The Head of the Department of Zoology, University College, Hull.

Director of the West African Fisheries Research Institute, Sierra Leone—The Under-Secretary of State, Colonial Office, Research Department, Sanctuary Buildings, Great Smith Street, London, S.W.1.

Lecturer in the Mathematics Department—The Principal, Northampton Polytechnic, St. John Street, London, E.C.1.

Laboratory Assistant (woman) at Aylwin School, Southwark Park Road, S.E.16—The Education Officer (Estab. 2), London County Council, The County Hall, London, S.E.1.

Lecturer in Physiology up to B.Sc. standard—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S.W.3.

Entomologist in the Research Division of the Department of Agriculture and Forests, Sudan Government—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Entomologist Agriculture'.

Chief Mechanic to take charge of workshop attached to medical research unit—The Director, Radiotherapeutic Research Unit, Medical Research Council, Hammersmith Hospital, Ducane Road, London, W.12.

Photographic Technician with experience in photo-micrography, for M.R.C. Biophysics Research Unit—Prof. J. T. Randall, King's College, Strand, London, W.C.2.

Technician (with considerable experience in routine investigation) in the Department of Chemical Pathology, and a Technician to be responsible for preparation of teaching classes in Organic Chemistry, Biochemistry and Chemical Pathology—The Secretary, Charing Cross Hospital Medical School, 62 Chandos Place, London, W.C.2.

Senior Scientific Officer (G. 224/48A) to take charge of Biology and Chemistry Section, a Senior Scientific Officer (A.185/48A) to take charge of Physics and Electronics Section, a Scientific Officer (F.429/48A) for investigation of deterioration of materials and complete equipment exposed under tropical conditions, a Senior Experimental Officer (A.186/48A) to lead a team working on Electronics, Experimental Officers and Assistant Experimental Officers for work in the following Sections : Chemistry (F.430/48A), Biology (G.225/48A), Physics and Electronics (A.187/48A), General Engineering (C.415/48A), at the Ministry of Supply Tropical Testing Establishment, Port Harcourt, Nigeria—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No.

Metallurgist to work in the Mechanical Testing Section—The Secretary, British Non-Ferrous Metals Research Association, 81–91 Euston Street, London, N.W.1.

Senior Laboratory Assistant—The Headmistress, Maidstone Grammar School for Girls, Maidstone.

Theoretical Physicist or Mathematician (preferably with knowledge of matrix and tensor calculus), and an Experimental Physicist (if possible with some experience in instrument design) for research on the rheological properties of materials, an Electronics Physicist for fundamental research in applications of microwaves, and a Physicist with experience of high vacuum and interferometry techniques—The Secretary, British Rayon Research Association, Bridgewater House, 58 Whitworth Street, Manchester 1.

Analyst in the Department of Chemistry of the School of Agriculture, Sutton Bonington, Loughborough—The Registrar, University College, Nottingham.

Assistant Lecturer in Geography, a Lecturer in Pharmacology, a Demonstrator in Pharmacology, an Assistant Lecturer in Pharmaceutics, and a Demonstrator in Pharmaceutics—The Registrar, University College, Nottingham.

Physiologist to obtain experience for from 1 to 2 years in American teaching and research—Prof. H. C. Bazett, Department of Physiology, University of Pennsylvania, Philadelphia, Pa., U.S.A. (write by air mail).

Physicist—The House Governor, Royal Hospital, Wolverhampton.

Assistant Game Warden—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Assistant Game Warden'.

Assistant Lecturer (temporary) in Mathematics—The Registrar, University College, Singleton Park, Swansea.

Inspector of Agriculture, Department of Agriculture and Forests, Sudan Government—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Inspector of Agriculture'.

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DISTRIBUTION OF SCIENTIFIC MAN-POWER

FROM the national point of view, a proper balance must be struck between productive effort and research effort, as in any successful private business ; it is the task of management to secure that the appropriate balance is achieved, and that it is achieved without diverting too many creative and fertile minds to the equally essential task of administration. This is the point of view from which the present organisation of scientific and industrial research in Great Britain must be considered. As Sir John Anderson rightly said in his lecture to the Society of Chemical Industry when he received the Messel Medal on July 14, Great Britain has been a pioneer among the nations in the organisation of scientific research ; but nevertheless we must have the organisation of science in the public service constantly under review. In particular, it is essential that we should consider whether, by any changes in the existing organisation or by more careful use of our limited scientific man-power, we can rectify admitted weaknesses in the development of research results, and in the supply of trained scientific men and technologists.

It seems clear from its first report that the Advisory Council on Scientific Policy is concerning itself with this broad question ; but it is equally important that the scientific and industrial world should be provided with adequate data on which to base a sound and independent judgment of the correctness of Government organisation and policy. That is the fundamental reason why early resumption of the publication of full reports from the Department of Scientific and Industrial Research is so important. Moreover, since a sound judgment cannot reasonably be made on the results of any one year, it is the more important that there should be available as early as possible a full account of the war effort, and especially before the Department is irretrievably committed to any schemes of expansion which involve large drains on man-power or equipment.

Admirably as the recent report from the Chemistry Research Board (see p. 228 of this issue) fills the need from one point of view—and there can be nothing but praise for much of the work done and also for the special attention being given to the development of new techniques for the benefit of both industry and science—a striking feature of the report illustrates the necessity for completing the picture. This is the way in which the work of the Chemical Research Laboratory is linked up with that of other Government institutions and departments. The Corrosion of Metals Section, for example, has collaborated with the Light Division of the National Physical Laboratory and with the British Iron and Steel Research Association, as well as with the Water Pollution Research Laboratory, the British Cast Iron Research Association and the British Non-Ferrous Metals Research Association, and has carried out work for the Ministry of Supply and the Ministry of Works. The High Polymers and Plastics Section has worked with the Engineering Division of the National Physical Laboratory and the Forests Products Research Laboratory, and the Coal Tar Section with the Heat Section of the Physics Division and the Metrology Division of the National Physical Laboratory. The Chemistry Research Board itself directs attention to contacts maintained with other departments and to field trials by the Colonial Office on the control of nagana in Africa by the use of phenanthridinium compounds prepared in the Laboratory, as well as the development of the production of food yeast in Jamaica.

There can be no question as to the value of such collaboration in achieving economy of effort and equipment, and whatever doubts are entertained as to the value of the research association movement, there are *a priori* reasons for believing that the work of such institutions as the Chemical Research Laboratory is thoroughly sound, and that under the Chemistry Research Board it is making an important, and possibly a vital, contribution to the advancement of science and to industrial development, apart from the study of the specific scientific problems which arise in the public service. The very way in which it is interlocked with the work of other bodies, however, makes it important that we should consider the Government organisation of research as a whole. Otherwise there is danger that justifiable expansion at one point may have serious and undesirable repercussions on activities elsewhere which it is vital to maintain or even expand.

It was noticeable that, in his address at Edinburgh, Sir John Anderson was purely descriptive and neither commended nor condemned what he described, though those who followed his survey closely might perhaps have gained from his inflexions some idea of the general trend of Sir John's own mind. Neither can it be said that the Advisory Council on Scientific Policy has in its first report addressed itself to the broadest aspects of the question. The Council was asked by the Government to make recommendations on the specific questions, *inter alia*, of the appropriate organisation for scientific research within the Government, with special reference to research on building and on fuel and power, and the appropriate form of research effort to assist the maximum increase in national productivity during the coming decade. In regard to the former of these problems, the Advisory Council was asked to consider, in particular, what should be the respective functions of Government departments, of the research councils and of outside bodies (including the boards of socialized industries) in carrying out research.

The Advisory Council recognizes that on one hand research of the highest quality depends on a freedom which is difficult to reconcile with the normal conditions of Government work, and on the other hand, that close contact between the research worker and the user of the results of applied research is essential in order that the results obtained may be of practical value and supply data and a satisfactory foundation for the research itself. It therefore devoted considerable time at the outset to discussion of the general principles which should apply to the organisation of Government research and its application, and as a result reached agreement on two general principles. First, the executive department should be responsible for identifying problems requiring research, settling their order of priority, deciding where the various investigations should be carried out and applying their results. Secondly, the research councils, and particularly the various branches of the Department of Scientific and Industrial Research, should continue to be free to initiate background research where they think fit, free from administrative control of the executive departments and consequently from considerations of day-to-day expediency.

Like Sir John Anderson in his lecture, the Advisory Council rejects the idea of a Ministry of Science and agrees that no attempt should be made to concentrate responsibility for carrying out all Government scientific research on the Lord President of the Council. It considers that this would intensify rather than diminish the old cleavage between science, administration and policy; although the Lord President should assume a particular concern for such branches of scientific research as have a wider application than to the problems of a particular department.

While there will probably be much general support for these views, it will be noted that the Advisory Council does not discuss in the present report the effectiveness or adequacy of the general structure, or whether its disposition as between Government and industry could be improved with advantage to the public welfare. This is the more important in view of the next conclusion, that if the executive departments are to discharge their considerable scientific and technical responsibilities thus defined, they will require to employ considerable scientific staffs, corresponding to the operational research units attached to the Service Ministries and Commands during the War. The appointment of a 'chief scientific officer' by the departments, provided with an adequate staff, however admirable in principle, may well be open to question on practical grounds at the present juncture. Can we really afford to withdraw such men from production while we are still awaiting the increase in scientific and technological man-power recommended by the Barlow Report?

The recommendation, it is true, is in line with the observations in the report of the Select Committee on Estimates, which in its third report for the Session 1946–47, dealing with expenditure on research and development, referred to the absence of sufficient provision for the identification of scientific problems in day-to-day administration as one of the greatest weaknesses in the Government organisation. The Select Committee itself recommended the appointment in all executive departments of scientific advisers who should have a high standing and direct access to the policy-forming level. There can only be welcome for any proposal which will give the scientific man more influence in guiding the formulation as well as the administration of policy, and for the recommendation that executive departments to the work of which science can contribute should assume a more positive role than hitherto in the organisation and direction of research required for their own purposes and in supervising the application of its results. Nevertheless, however urgent and essential may be the appointment of chief scientific officers for the planning of the present Government research programme in the best way to meet national needs, the question must still be asked where the men are to be found, and whether there are not other activities which could be curtailed or discontinued to release men for such work.

These recommendations were submitted by the Advisory Council in a general report on May 22, 1947, and two such appointments have since been made, to the Ministry of Food and to the Home Office respectively. The same principles have been applied to the Council's consideration of the special requirements of building research. Here it recommends that the Department of Scientific and Industrial Research should retain full responsibility for scientific research and initial development in building, as well as its freedom to initiate research and undertake investigations at the direct proposal of the building industry. The Ministry of Works should retain the broad responsibilities indicated for executive departments in general, including that of keeping the technical development of the building industry under review, promoting the final stages of development, and encouraging the use by industry of the results of research. For the discharge of these scientific functions the Advisory Council recommends, in addition to the appointment of a 'chief scientific officer', a scientific advisory council of scientific men and representatives of the building industry in equal proportions, and such a Council on Building and Civil Engineering and Development was established on December 8, 1947. Under these proposals, the responsibility for identifying the problems requiring research and determining their priority, as well as for initiating research in the sociological or economic field, rests with the Ministry of Works. In like manner the Advisory Council recommended that the scientific and engineering staff of the Ministry of Fuel and Power should be substantially strengthened, and that a 'chief scientific officer' should be appointed with adequate status and with responsibility for making a broad strategic survey of the problems on which to base a general research problem for the fuel and power industries. He would be assisted by an advisory council including not only scientific men but also economists, administrators and men of wide practical experience in the nationalized industries. The Advisory Council has rejected a suggestion to transfer the Fuel Research Station to the Ministry of Fuel and Power; but advised that the Station should continue to act as an agent in carrying out such research as the Ministry may decide to allocate to it.

There can be no doubt that, under its terms of reference, the Advisory Council on Scientific Policy is discharging important functions not hitherto provided for, and its first report encourages the hope that the Council will go much more closely into such important questions as the appropriate pattern for the scientific organisation of Government departments in general as well as that of the general structure of the organisation of scientific and industrial research in Britain, the principles on which research in the nationalized industries should be organised and the overall requirements of scientific man-power and the appropriate measures for its recruitment and training. Meanwhile, its report should reassure those who fear that the conduct of scientific research by Government departments or the research councils will be over-planned. Its pronouncements on the status of 'chief scientific officers' will be welcomed by those who have urged, as has been done in these columns for many years, that the scientific man should be given the status which will enable him to make his voice heard effectively in the determination of policy where scientific factors are involved ; and that the possession of scientific qualifications should not constitute a bar to advancement to positions of the highest administrative responsibility when the requisite administrative talent is joined to such qualifications.

Nevertheless, the report will inevitably cause some misgivings. As is rightly emphasized, to meet the urgent requirements of the economic situation the direction in which scientific research and development should be promoted cannot be determined solely from the point of view of science itself; and its gravity makes it essential to develop quicker and more efficient application of the results of fundamental research, demanding in turn an efficient scientific organisation in executive departments and a better supply of the type of technologist who can effectively apply the results of fundamental research. It is no easy task to strike the right balance between long-term and short-term interests, between the needs of academic and industrial research, between the requirements of science and Government; and however valuable the Advisory Council may prove in future in deciding such issues in terms of an overall scientific and economic policy, the present report will not satisfy those who believe that an excessive proportion of the general as well as the scientific man-power of Britain is being diverted from productive to non-productive occupations.

This is not to suggest that research is non-productive; but as we have already stressed, if too large a proportion of scientific workers is employed on research or the dissemination of its results, there will not be enough available to apply those results. The Advisory Council does not entirely ignore this question of production; but the special Committee on Research and Productivity appointed by the Advisory Council, with Sir Claud Gibb as chairman, and the functions of which have now been transferred to a new and independent Committee on Industrial Productivity, was concerned more especially with the human factor in production, and such matters as nutrition and production and the improvement of technical information services. The fundamental question of the proper distribution of the scientific man-power of Britain between defence and civil requirements is only touched upon in that part of the Advisory Council's report which deals with scientific man-power, and even here the vital issue of the distribution between productive industry and other civil requirements, including services of all kinds, is not adequately examined. This, however, is really the most important section of the Advisory Council's report, and requires fuller discussion in the light of the revised estimates of university expansion and the prospective demand for scientific man-power which have appeared since the Barlow Committee reported in 1946.

CHEMICAL SYNTHESIS MADE EASY

Synthetic Methods of Organic Chemistry

A Thesaurus. By W. Theilheimer. Vol. 1: 1942–1944. Translated from the German by Hans Wynberg. Pp. x + 254. (New York and London: Interscience Publishers, Inc., 1948.) 30*s*.

THIS is a new type of organic chemical publication. The volume under review is a translation of a German version published in Basle in 1946, and purports to cover the original literature of the period 1942–44. In fact, references to earlier publications are frequently given. Volume 2, covering the literature of 1945–46, has now been published in German, and presumably an English translation of this will appear in due course. If there is to be a series of volumes appearing at two-year intervals, then steps should be taken to reduce this time-lag between publication of the original Swiss edition and the appearance of its translation. The work is described as a "Thesaurus", a word which is defined by the Shorter Oxford English Dictionary as meaning a 'treasury' or 'storehouse' of knowledge. This savours somewhat of grandiosity, and it remains to be seen whether organic chemists will regard the work so highly as the description implies. For the present, they will be content to accept the commendation of Prof. Reichstein in the foreword which he contributes, and to give the volume a conspicuous place on their shelves of reference works.

The author's intentions are admirable. The present volume summarizes more than seven hundred reactions, with literature references, and the information collected will be of value not only to those who are interested in synthetic methods but also to those who have a general interest in organic reactions and their current applications. As Prof. Reichstein points out in his foreword, the actual methods of organic chemistry are not classified and recorded in such a highly systematic way as are new compounds. Until recently the best available reference book for methods was "Houben", which is now a little out of date, and although there are excellent newer books on methods, such as "Organic Reactions" and "Newer Methods of Preparative Organic Chemistry", these deal only with reactions in strictly circumscribed fields.

Dr. Theilheimer has attempted to give a systematic survey of reactions likely to be of value in organic synthesis. This has of necessity meant making a selection, based on personal preference. The supreme difficulty of the project has been to devise a system of classification sufficiently simple to enable the entries relating to the desired reactions to be found readily; and sufficiently elastic to allow for an increase in the range of reactions to be included in future volumes. To meet this difficulty the author has devised a new form of symbolism, based on the system of classification used by C. Weygand in his "Organisch-chemische Experimentierkunst" (also available in an English translation). Probably familiarity with the system will enable the user to find at once the references to the reaction in which he is interested; but until he has acquired this familiarity the novice will be inclined to flounder rather helplessly, and will probably tend to rely on the index which, although good, is by no means perfect. It would have been of assistance if a table of contents could have been included, with page numbers of the main headings, such as "Formation of C–C Bond".

For the most part, the methods enumerated do not appear to be new, but are examples of reactions already known, taken from the literature of the period under review. It is doubtful whether the ideal system of classification has been found. The system used results: (*a*) in the grouping together of reactions which have very little in common except the nature of the linkage which appears in the product, and (*b*) in the wide dispersal of very similar reactions. As an example of the latter we find that reactions numbered 652 and 768 are of precisely the same type, namely, union of aromatic nuclei by elimination of hydrogen halide by means of potassium hydroxide. There are some inconsistencies. Aromatic rings are sometimes shown with Kekulé double bonds and sometimes not; it is curious to find potassium alcoholate listed in one place as a reagent for the preparation of α-*iso*nitrosoketones and in another place sodium nitrite. Also, it is a little odd to find acetic acid and sulphuric acid among the reagents used for nitration. The formulæ appear to have been transcribed exactly from the Swiss edition, even to the errors which have been detected in the formulæ given under numbers 192 and 695. In some cases translation has been accompanied by the appearance of new errors. Thus, in section No. 147 the name of an author is spelt incorrectly and in section No. 152 2-acetylfluorene is erroneously given as 8-acetylfluorene. These, however, are minor matters, and the author is to be congratulated on a courageous attempt to fill a serious gap in the literature of organic chemistry.

J. W. COOK

BIOLOGICAL STANDARDIZATION OF VITAMINS

The Biological Standardisation of the Vitamins

By Dr. Katharine H. Coward. Second edition. Pp. vii+224. (London: Baillière, Tindall and Cox, 1947.) 16*s*. net.

SINCE the early 1930's, Dr. Katharine Coward has worked untiringly to popularize sound methods of biological standardization of vitamins. The first edition of her book appeared in 1938. In bringing out the second she has the satisfaction of preaching to the almost converted. The last ten years have seen no spectacular change in the principles of biological assay of vitamins, but much refinement of technique and broadening of scope. Dr. Coward has catered for both, but has followed her original plan of discussing only those tests of which she has personal experience and only those vitamins for which international standards are available. This strictly orthodox approach is perhaps too harshly restrictive; of the whole gamut of the B vitamins now known in the pure form, vitamin B_1 is the only one considered; a mention of riboflavin, pyridoxin and pantothenic acid, for which reliable tests are available, would certainly have been useful.

The presentation of the statistical methods has been considerably revised and improved. The treatment is very sound and comprehensive, though perhaps, for a beginner, some parts are too condensed, and scarcely enough stress is laid on criteria of significance.

Dr. Coward might well consider amplifying some of these useful statistical chapters; she could gain space for it by cutting out unnecessary repetition in the description of biological technique. To quote only one example of redundancy, the formula of one salt mixture is given in full no less than three times, on pp. 32, 135 and 155.

Most misprints of the first edition have been corrected; but by a strange fluke 'ingestation' has again escaped unscathed, to appear repeatedly on pp. 17–19.

In too many branches of science the standard monograph is a dry-as-dust compilation by scissors and paste. Vitamin workers in the field of biological standardization are fortunate to have in Dr. Coward a mentor who knows and loves the land through which she guides them. We wish her well in the task of charting for her third edition the discoveries of the next ten years.

S. K. Kon
P. White

VEGETATION OF THE ARGENTINE

La vegetación de la Argentina

By Profs. L. Hauman, A. Burkart, L. R. Parodi, and A. L. Cabrera. (Geografía de la República Argentina. Vol. 8.) Pp. 350. (Buenos Aires: Gaea, Sociedad Argentina de Estudios Geográficos, 1947.)

Up to the present, the botanist or agriculturist desiring information on the plant cover of the Argentine has been obliged to seek it among a large number of scattered publications, some in rather obscure periodicals, many out of print. Assistance has been given in recent years by Castellanos and Perez-Moreau's valuable classified bibliography of South American botany, published in *Lilloa*, volumes 6 and 7, 1941, and by the reprinting of some of the older works, such as, for example, Hieronymus' "Observations on the Vegetation of the Province of Tucumán", 1874, republished in 1945 by the University of Tucumán; but no compact account of the plant resources of this extremely varied country has yet been available. The appearance of the volume now published by the Argentine Society of Geographical Studies and written by botanists of authoritative position is, therefore, much to be welcomed. It is concise and so far as possible complete, although as Cabrera, writing of the Patagonian shrub steppe, notes, there is still much room for botanical and sociological investigation. The material was ready for publication in 1939; but printing had to be deferred until 1947.

The work has a geographical bias, and the subject-matter is arranged in accordance with the natural regions into which the Argentine is divisible. These are mapped by Parodi. Hauman, the senior author, has written the introduction and the sections which deal with the forests of Misiones and those of the 700-km. long narrow strip running from north to south through the provinces of Salta, Jujuy and Tucumán; with the Gran Chaco; with the enormous scrub or thorn woodland area known as the *Monte*; and with the sub-Antarctic forests and the Andean regions. Burkart describes the Mesopotamian region lying between the Rivers Paraná and Uruguay, in which forest alternates with savannah, the latter predominating. L. R. Parodi contributes the account of the great grass steppe of the pampas, and A. L. Cabrera that of the Patagonian shrub steppe.

The reader is impressed by the wealth of plant resources of the Argentine and by the great diversity of the material described. The influence of cultivation and stock-raising is perceptible principally in the pampas, not always to the detriment of the plant cover. Where, however, the exploitation of light lands in dry, wind-swept areas is excessive or even is practised at all, there is grave risk of wind erosion. This is so in a very large part of the middle west, where shifting sand dunes 30–40 m. in height, practically denuded of all vegetation, are to be seen.

G. M. Roseveare

GUSTAV FECHNER

Religion of a Scientist

Selections from Gustav Th. Fechner. Edited and translated by Walter Lowrie. Pp. 281. (London: Kegan Paul and Co., Ltd.; New York: Pantheon Books, Inc., 1946.) 17*s*. 6*d*. net.

Dr. Lowrie's biography of Fechner and selections from his writings make an interesting book. Fechner was a remarkable and most unusual kind of man, as unlike the standard nineteenth-century German professor as can be imagined; a poet, humorist and above all a Romantic. He is remembered chiefly in connexion with the Weber–Fechner law. His work was certainly a landmark in the study of sensory response. But the range of validity of the Fechner law is restricted; it states the value of a ratio between two physical quantities (total stimulus and least discernible increment), and what it signifies psychologically is doubtful. The assertion on the dust cover of this book, that through Fechner "psychology developed into an 'exact' science susceptible of mathematical treatment", is, to put it mildly, misleading. Dr. Lowrie himself says nothing of the sort.

There is a legend that Fechner was a physicist who was afflicted in middle life by an illness which affected his sight and probably his reason, and he thereafter gave up science and took to religious mysticism. Dr. Lowrie's narrative explodes the legend. Fechner's best-known religious work, "Life after Death", was published four years before his illness, and the work on Fechner's law was done several years after. All his life he found the mechanistic view of physical science intellectually stifling, and fought against it; first with parodies and jokes, afterwards more seriously and constructively. He took a pan-psychic or pan-theistic view of the natural world rather characteristic of the Romantics of his period. Unlike most of them, however, he did not turn his back on science; instead he tried to enlarge the scientific insight.

Fechner was rash in speculation and perhaps entirely mistaken in thinking that scientific thought could transcend its traditional limits. The mistake was not that of a man who is just stupid or ill-informed. The illness he had still remains mysterious, but does seem to have originated in mental conflict of some kind. Physiologists should note the strange diet of raw lean ham soaked in wine and lemon juice which initiated Fechner's recovery from his digestive troubles (p. 38).

A. D. R.

PHYSICAL AND CHEMICAL ASPECTS OF RUBBER TECHNOLOGY

THE Rubber Technology Conference, held in London during June 23–25 under the auspices of the Institution of the Rubber Industry, provided the first opportunity since the War for scientific workers and technologists in this field from many countries to meet for a general discussion of their problems. The papers presented covered a very wide range of subjects, from purely scientific to highly technical; this short article is an attempt to review only the more scientific aspects of the matters discussed.

Physical Aspects

It has been known for a long time that natural rubber crystallizes on stretching, and it is generally supposed that this phenomenon has an important bearing on such mechanical properties as tensile strength and resistance to tearing. In a paper on the degree of crystallization in natural rubber, Dr. J. M. Goppel discussed his recent X-ray studies of the absolute amount of crystallization as a function of the degree of extension of the rubber. For a highly extended vulcanized rubber, the fraction of crystalline material was found to be only 29 per cent, which is very much lower than figures given by the earlier work of Field (60–80 per cent). Correspondingly low figures were obtained for frozen raw rubber (unstretched), for which the degree of crystallization was found to increase with time of storage. The highest figure obtained was 38 per cent for crepe rubber which had been stored for twenty-nine years. It was shown also that estimates of crystallinity from density changes reported in the literature led to values of the same general magnitude.

Papers dealing with the design of engineering components in rubber were contributed by Mr. R. S. Rivlin, who dealt with the theoretical basis of this subject, and by Mr. H. L. Jenkins and Mr. H. D. Cooper, whose approach was from the experimental side. Mr. Rivlin referred to the inherent limitations of the classical theory of elasticity—particularly the restriction to small deformations—and gave an outline of recent developments in the theory of large elastic deformations, with particular reference to incompressible materials, that is, materials like rubber, the volume of which is substantially constant on deformation. Rivlin's theory is centred on the existence of a unique work of deformation or stored-energy function corresponding to a specified state of strain; from this stored-energy function the generalized stress-strain relations are readily derived. The theory has been applied to a number of problems of practical interest, among which shear mountings and torsional couplings were particularly considered.

From experiments on the axial compression of cylindrical blocks between lubricated plates (to allow free lateral expansion), Mr. Jenkins and Mr. Cooper showed that the properties of rubber in compression can be adequately represented by the formula derived from the statistical theory of James and Guth. This formula, which had previously been applied mainly to rubber in tension, involves only one physical constant k, which is analogous to the modulus of rigidity in the classical theory. The experimental values of k are nearly independent of the ratio of length to diameter of the cylinder. In the case of shear, the theoretical linear relation between stress and strain was found to be inadequate; but the experimental results can be represented by the use of the same constant k, together with an empirical 'shape function'. It was pointed out, however, that the values of k are dependent on the time of loading or 'load history' adopted, and a machine was described which has been designed to facilitate the application of different load-history patterns.

Another aspect of the mechanical properties of rubber, the rate of retraction from the stretched state after release of the tension, was examined by Dr. B. B. S. T. Boonstra. The technique employed depends on the breaking of electrical contacts by the motion of the rubber, the time between successive breaks being measured by the fall in potential of a condenser discharging through a resistance. Differences were found both in the rates of retraction, and in the residual temporary 'set', between the various rubbers (natural and synthetic) examined. The speed of retraction did not appear to be correlated with rebound resilience; for example, butyl rubber, though showing very low rebound resilience, gave a retraction-rate only slightly below that for natural rubber.

The two sessions devoted to the discussion of compounding ingredients included a number of papers dealing with the effects of fillers, particularly carbon black, on the physical properties of rubber. Although carbon black is regarded as the outstanding 'reinforcing' filler for rubber, there appeared from the discussion to be no general agreement as to what constitutes reinforcement, though tensile strength, stiffness and abrasion resistance were the most frequently quoted criteria. In view of this lack of definition of the concept, it is not surprising to find that the mechanism of reinforcement is still but imperfectly understood. A new and interesting fundamental approach to this problem was provided by Dr. W. R. Smith and Mr. W. D. Schaeffer, who have attempted to evaluate the surface activity of various carbon blacks by measurements of the heats of adsorption of gaseous hydrocarbons. Their results reveal a marked variation in heats of adsorption with degree of surface covering (up to 1·5 molecular layers), which points to a selective adsorption at specially active sites. How far these conclusions are directly applicable to the carbon-rubber system has yet to be established; but the evidence suggests that there is a rather close correlation between the initial heats of adsorption and the reinforcing power of the black.

A general physical approach was adopted in the paper by Dr. E. Guth on the theory of filler reinforcement. Guth's theory concentrates attention on the effect of included rigid particles on the modulus of an elastic medium. This theory leads to an expression for the modulus in terms of the volume concentration of the filler which may be regarded formally as an extension of the well-known Einstein relation for the viscosity of a liquid medium containing solid particles in suspension. By means of this equation it should be possible to distinguish between approximately spherical particles, and particles possessing marked geometrical anisotropy. The experimental evidence quoted by Dr. Guth indicated that non-reinforcing fillers like calcium carbonate correspond to the case of spherical particles, while reinforcing fillers require the assumption of highly elongated particles. Since individual carbon particles are roughly spherical in shape, this is regarded as evidence for the formation of elongated chain-like agglomerates of particles, such as have frequently been observed in the examination of blacks under the electron microscope. Indeed, by a suitable modification of the theory it is possible to include the effect of non-sphericity in terms of a 'shape factor'; the shape factors thus derived are found to agree reasonably well with the shapes observed in the electron microscope. This conclusion received further support from Dr. L. H. Cohan, who presented electron microscope evidence for the existence of chain-like structures, which appear to be of characteristic form for any particular mode of preparation of the black. A large number of measurements on a particular black yielded an axial ratio of 6, and this value was found to account for the observed increase of modulus, on Guth's theory, up to 25 per cent concentration.

This theory of reinforcement, as the subsequent discussion showed, is not without its difficulties. According to Dr. L. Mullins, the stiffening effect of carbon black 'wears off' after a small number of repetitions of the extension of the rubber, and gradually reappears on resting, suggesting a breakdown of the chain structures due to stressing. This aspect was further discussed by Mr. A. F. Blanchard and Dr. D. Parkinson, who made use of measurements of electrical conductivity, which is directly related to a net structure of the carbon particles, to throw light on the breakdown and re-formation of these structures. Their conclusion is that the degree of breakdown of structure on extension is relatively of a minor character, certainly not sufficient to account for the observed reduction of stiffness, which they attribute rather to the rupture of the bonds between the carbon particles and the rubber.

A contribution to the study of the optical properties of rubber was presented by Dr. L. A. Wood and Mr. L. W. Tilton, who described an accurate method of measuring refractive indices, in which the specimen was moulded into prismatic form between glass plates. Data were obtained at five different wave-lengths, and over a range of temperature, and compared with various theoretical formulæ for optical dispersion. An interesting result which emerged is the disparity between the isoprene unit and normal mono-olefins, which suggests that the middle C—C bond may partake of the properties of a double bond. A corresponding abnormality in bond-length was found from an X-ray analysis by Jeffrey of the closely comparable low-molecular crystalline compound, geranylamine hydrochloride.

The curious luminescence which may sometimes be observed on tearing rubber in a dark room was the subject of a paper contributed by Dr. A. van Rossem. From numerous experiments it has been shown that the emission of light is related to the type of filler with which the rubber is compounded. The effect was observed only in the presence of non-reinforcing fillers. The suggestion was made that the phenomenon is due to a discharge of electricity through the vacuoles which are known to be formed in such filled rubbers under tension.

On an entirely different subject, Prof. H. W. Melville and Mr. C. R. Masson reviewed recent techniques for the measurement of very small osmotic pressures, as encountered in the determination of molecular weights of high polymers. The difficulty of such measurements arises from the length of time required for the attainment of osmotic equilibrium. It was shown that this may be greatly reduced (*a*) by the use of bacterial cellulose as a semi-permeable membrane, and (*b*) by the use of a dynamic method involving the measurement of the rate of approach to equilibrium. Another technique described was the 'osmotic balance' method, in which the diffusion of liquid into the cell is determined by weighing instead of by measurement. This method was claimed to give remarkable sensitivity, and should prove useful for the determination of molecular weights hitherto considered to be beyond the range of investigation by osmotic methods.

Among a number of papers dealing mainly with the technical evaluation of the properties of rubbers, many questions of interest to the physicist were touched on. Particular mention may be made of two papers on the resistance of rubber to tearing, by Dr. J. M. Buist and Dr. H. A. W. Nijveld, respectively, and one by Dr. J. R. Scott and Mr. R. W. Whorlow on the interpretation of plasticity measurements.

Chemical Aspects

Although most aspects of the chemistry of elastomers were implicit in the many matters discussed from a technological point of view, the actual contributions to rubber chemistry were limited to the three main topics of oxidation, vulcanization and rubber halides. There were also some subsidiary advances in chemical knowledge in the more technical discussions on synthetic rubbers and on latex.

On the subject of oxidation, papers presented by Dr. R. L. Stafford and by Dr. J. Le Bras and Mr. A. Salvetti were both primarily concerned with the mode of action of inhibitory substances. It has been suggested that in rubber chemistry the latter fall into two distinct classes, termed antioxidants and deactivators respectively, typical examples being phenyl-β-naphthylamine and mercapto-benzimidazole. The former fulfil the normal function of retarding oxygen attack, whereas the latter reduce the deleterious chain-scission reactions associated with oxidation of rubber without lessening the overall combination of oxygen. Much of the earlier work on the autoxidation of rubber and allied substances has been carried out with strong sources of light (for example, ultra-violet), thus giving a reaction which proceeds at a rate many times that of the dark reaction and which is unretarded by the usual antioxidants. No fundamental change in the nature of the reaction or of the effect of antioxidants was encountered by Dr. Stafford when the oxidation was effected with a weak light source with the object of obtaining a rate of photo-activated absorption of the same order as that of the dark thermal reaction.

However, although neither phenyl-β-naphthylamine nor mercapto-benzimidazole (the antioxidant and deactivator studied) was effective against light-activated absorption, a mixture of the two was found to possess considerable efficacy. The precise mechanism of this effect, which is in accord with earlier work of Le Bras, is still unsolved.

For the study of these oxidation effects with rubber, Dr. Le Bras has designed an improved type of manometric apparatus in which the oxygen is generated as required by electrolysis of a concentrated solution of copper sulphate.

The chief difficulty in this type of work is the fluctuation in results occasioned by the variability of composition of crude natural rubber. Assistance in this direction was given by Mr. G. Martin, who described a simplified method of preparing pure rubber hydrocarbon for oxidation studies. The method involves addition, to the ammonia-preserved latex, of a soap, which displaces the protein from the rubber particle surfaces, followed by repeated creaming, coagulation with acetic acid and extraction with acetone.

Considerable interest was shown in a paper by Dr. W. T. Chambers on the direct determination on a micro-scale of oxygen in rubbers. His method is an application of that of Unterzaucher involving reduction of the oxygenated compound with carbon, the resulting carbon monoxide being oxidized by iodine pentoxide and the liberated iodine estimated after oxidation to iodate. The ability to determine small percentages of oxygen directly, instead of by difference from the carbon and hydrogen figures, will be of great value in rubber oxidation studies. The accuracy of this method is of the order of ±0·01 in the range 0–0·5 per cent oxygen and ±0·04 in the range 1·0 to 2·0 per cent oxygen. This precision was not sufficient to show conclusively that the molecular breakdown of rubber on milling is always associated with oxidation, but Dr. Chambers was able to demonstrate this effect in one run with pale crepe rubber.

In his presidential address to the Conference, Sir Robert Robinson mentioned the advances that had been made in the knowledge of polymerization and the importance of the introduction of intermolecular cross-linking into natural and synthetic polymers. Dr. G. F. Bloomfield was able to present more evidence on the nature of the cross-links arising in the vulcanization of rubber with sulphur. In this connexion methyl iodide has proved a useful reagent for determining the type of C—S link present. Earlier work has shown that methyl iodide at 25° C. removes the sulphur from diallylic sulphides to form trimethyl sulphonium iodide, and since the latter is obtained from the reaction of methyl iodide with rubber/sulphur vulcanizates, it has in the past been assumed that diallylic groups must be present in appreciable numbers. The unreliability of this conclusion (which is, in any event, at variance with other vulcanization evidence) was made apparent by Dr. Bloomfield's demonstration of a similar formation of trimethylsulphonium iodide from compounds containing the sulphur atom between one allylic and one tertiary grouping. It is known that the reaction of polyisoprenic compounds with sulphur leads to the formation of cyclic and cross-linked sulphides, and the evidence presented in this work is consistent with the view that the allyl-tertiary sulphide grouping is a characteristic of both.

The importance of the non-hydrocarbon constituents of natural rubber in the process of vulcanization was demonstrated by Mr. G. Martin in his work on highly purified rubber. The catalytic effect of these other constituents, the absence of which was found markedly to reduce the vulcanizing efficiency of sulphur, is a subject requiring further careful investigation.

A study of the hydrochlorination of rubber in latex by Dr. G. J. van Veersen had theoretical as well as practical significance. The reaction of hydrogen chloride with rubber in solution shows an induction period, the length of which is proportional to the solubility of the hydrogen chloride in the solvent. It was suggested that a solution of rubber in dioxane (for example) represents a system of two electron donors competing for the hydrogen chloride to form co-ordination complexes. During the induction period, the speed of the reaction would be dependent on the affinity of the solvent for hydrogen chloride, but after saturation the rate would be independent of the nature of the solvent. In the reaction of hydrogen chloride with rubber latex it is necessary to prevent coagulation by reversing the charge on the rubber globules with a cationic soap. Under these conditions a very clean addition takes place with a minimum of cyclization.

It is difficult in a substance of high molecular weight like rubber to determine the nature of artificially introduced chemical groups. A contribution to this subject was made by Dr. G. Salomon, who read a paper by himself and Drs. C. Koningsberger and A. J. Ultée on the kinetic analysis of rubber halides. The method is based on the marked differences in reactivities of the various classes of aliphatic halides with organic bases. In the case of monohalides, this order is allylic > primary > tertiary (with some exceptions) > secondary > secondary monocyclic > vinylic. Polyhalides are more difficult to distinguish unambiguously, but their identification is rendered possible in many cases by comparison of the speeds of reaction with various bases. Using this kinetic method, evidence was found, for example, for the formation of secondary allylic chloride groupings in the chlorination of rubber under conditions favouring substitution, and of a series of polychlorides, the constitution of which has yet to be settled, by conventional chlorination.

The papers and discussion on synthetic rubbers were mainly technological in nature, although there were some points of chemical interest. Dr. R. P. Dinsmore directed attention to the fact that *GR–S* requires less combined sulphur than natural rubber to give a satisfactory vulcanizate, a point that may well be connected with the tendency of the $\Delta^{1:5}$ polyene system of rubber to give cyclic sulphides which contribute little to the strengthening of the molecular network. Mention was made of some of the physical and chemical properties associated with the characteristic structures of silicone, 'Buna-N' and butyl rubbers and of condensation rubbers of the type of 'Vulcaprene' (a di-isocyanate-modified polyesteramide).

An important contribution to our knowledge of the constitution of natural rubber latex was made by Miss L. N. S. Homans and Dr. G. E. van Gils. By centrifuging fresh unammoniated latex they were able to separate a yellow fraction which was a suspension mainly of non-rubber particles and which contained 6–8 per cent of the total solids of latex. These globules (termed 'lutoids') were easily visible under the microscope as transparent masses considerably larger than the rubber globules and were shown to consist of 80–85 per cent of water, with the solid content made up of proteins, salts and acetone-soluble substances, in the form of lipoids. Addition of ammonia brought the lutoids into solution, and dilution with water caused shrinking; but they were quite stable towards 0·1 *N* sodium chloride in aqueous solution. Removal of the lutoids resulted in marked changes in properties of the latex; for example, greater susceptibility to photoxidation, lower mechanical stability, greater thermal stability.

This new knowledge may have interesting biological implications in that it brings the constitution of latex more into line with the complexity of other physiological liquids.

A further attraction of the conference was an exhibition, arranged by the Dunlop Rubber Company, which included demonstrations of some of the more striking of the properties of rubber and methods by which they have been studied.

It is intended that the *Proceedings* of the Conference shall be published in a single volume. There is no doubt that this will prove a worthy companion to the *Proceedings* of the first conference, held in 1938, and a valuable source of reference to all interested in rubber science.

L. R. G. Treloar
R. F. Naylor

NUTRITION OF ATHLETES

A WHOLE-DAY meeting of the Nutrition Society on July 17 was devoted to the subject of the "Nutrition of Athletes". The first papers dealt with the physiology of muscular effort, and the meeting took a more practical turn later in the morning and in the afternoon session.

The meeting opened with a paper by Dr. Philip Eggleton of Edinburgh on "The Neuromuscular Mechanism". Physiological studies, he said, fall into three clear-cut categories. The first of these is the work on animals (including dog and man) which comprises measurements of work done, respiratory measurements, urine and blood analyses, nutrition studies and so on. The second category includes work on isolated muscles and nerves, which has been carried out mainly on cold-blooded animals because of the difficulty of using such preparations from mammals. Thirdly, there is work on the muscles of marine shell-fish. These last two methods have certain disadvantages in that it is difficult to apply the results obtained from them to the mammal, and particularly to the human being. Nevertheless, results from the three fields combine to produce a picture of the neuro-muscular machine which, according to the author, comes nearest to the physiologist's ideal—a description of physiological phenomena in terms of chemistry and physics—than has been achieved in respect of any branch of physiology, save perhaps the transport of gases by the blood.

Experiments in the first field have shown a simple relation between work done and food intake required; and there is also considerable evidence that manual labourers do not choose to eat carbohydrates but prefer fat and protein. This preference for a high protein diet by both manual labourers and athletes may be a survival perhaps of sympathetic magic; yet it may have as a basis the fact that meat is a good source of some of the B complex of vitamins. The preference for fatty food is more understandable, since it is an economical source of energy.

Dr. Eggleton went on to discuss A. V. Hill's work on the oxygen consumption during exercise, and said that in Hill's experiments the consumption of oxygen was about 4 litres a minute for men engaged in running at a pace which did not give them undue respiratory distress. However, these experiments only lasted for minutes, and Eggleton pointed out that the heart cannot pump 4 litres of oxygen into the body indefinitely; if the exercise has to be maintained for some time, an oxygen consumption of 1 litre per minute is nearer the upper limit. In this connexion Dr. Eggleton remarked that an athlete can build up an oxygen debt for events such as the 100-yd. sprint, and that in this event the rate of output of energy of the runner is 10–13 horse-power, which corresponds to an oxygen intake of 23 litres a minute—six times anything the heart can achieve. This debt is financed partly by the breakdown of glycogen to lactic acid and partly by the reserve of non-oxidative energy represented by the creatin phosphate content of muscle.

Dr. Eggleton discussed some of the aspects of the evolution of the neuro-muscular mechanism, and pointed out that one of the differences between invertebrate and vertebrate muscle is the presence of arginine in the muscles of the former and of creatine in muscles of the latter. Also vertebrate muscles contain considerable amounts of two di-peptides—β-alanylhistidine and β-alanyl-methyl-histidine—which are not present in invertebrate muscle.

In conclusion, Dr. Eggleton commented upon the apparent increasing athletic abilities of the human race, which he felt were more apparent than real, and upon the view that the decreased performances of British athletes recently is due to the changes in diet and habits engendered by the War, a problem which he felt should be left to later speakers.

Dr. Dorothy Needham spoke on chemical aspects of chemical contraction. In this field, Dr. Needham said that two lines of work, followed independently for about half a century, had only recently come together. One of these was the nature of the muscle machine, and the other was the nature of the essential fuel. Dr. Needham discussed the early work of Fletcher and Hopkins and of Meyerhof on the energy liberated by the formation of lactic acid in muscle, and of Lundsgaard's work on creatine-phosphate breakdown as a source of energy. Lohman's work in 1934, she said, suggested that adenosine triphosphate hydrolysis supplied the first energy-yielding reaction in muscular contraction.

The old idea that lactic acid production is an inevitable accompaniment of contraction has had to be discarded since it has been shown that much work can go on without any lactic acid formation. The most important constituent of the muscle machinery is the protein, and the modern phase began with the work of Edsall and von Muralt in 1930. Solutions of myosin showed the property of double refraction in flow, and this suggested some relation with the anisotropic bands of myo-fibrils. It appears that the contractile fibrils of muscle consist of polypeptide chains of myosin showing the α-fold, and owe their elasticity and contractility to their power of straightening out to the fully extended chain or folding up still further. The link between the machinery and the fuel comes from the observation that myosin has adenosine triphosphatase activity, so that myosin is not only the chief structural entity of muscle but is also the enzyme catalysing the chemical processes which lead to its own contraction. Szent-Györgyi has shown that another fibrous protein, 'actin', can be extracted from muscle, and that actin and myosin may unite to form fibrils of much greater length; this compound of the two proteins is called actomyosin.

It seems possible that some of the symptoms of fatigue may be due to the breaking of inter-molecular links which hold the partly folded polypeptide chains in place. If contraction is too severe and prolonged, too great a distortion may take place and unusual breaking of links or the formation of new and inconvenient ones may take place.

There are at the moment two main views on muscular contraction. One is that the contracting fibrils are made up of actomyosin. If adenosine triphosphate comes into contact with actomyosin fibrils, there is a rapid change of the protein with loss of water. Szent-Györgyi regards this as synonymous with contraction; on the other hand, Astbury has suggested that in resting muscle the fibrils are made more rigid and stable by combination in parts with a parallel *actin*-system, and that upon stimulation this combination is loosened by the action of adenosine triphosphate. When this happens the myosin can take up a shortened form of folding.

Group Captain C. A. Rumball described the practical uses to which investigations on the neuromuscular mechanism have been put in the choice of air-crews by the R.A.F. Pulse-rates while sitting, standing and under stress gave useful information. Diastolic blood pressures of more than 90 mm. were not acceptable, though up to 90 mm. was. However, it was pointed out that fifty-five marathon runners examined in 1909 had an average diastolic pressure of 93 mm. of mercury. One test which gave information of considerable value was that designed by Flack in 1920, in which a subject was asked to sustain a 40-mm. column of mercury in a U-tube manometer by a single expiration for as long as possible, and the pulse response examined. There are four main types of pulse response to this test; but only two of them, namely, a rapid and sustained rise to 10 or more beats per 5-sec. interval and a rapid rise followed by an abrupt fall to a low figure, indicated low functional efficiency.

Nutritional aspects of muscular activity were introduced by Dr. G. H. Bourne in a paper entitled "Vitamins and Muscular Exercise". Dr. Bourne pointed out that vitamins of the B complex play an important part in the reaction chains concerned with carbohydrate metabolism, and the demand for them might be expected to be increased in muscular exercise. A figure of fifteen times the normal requirement for vitamin B in severe exercise has been quoted. This would mean a daily intake of 22·5 mgm. (based on a normal daily requirement of 1–5 mgm. of vitamin B_1). To obtain this amount of vitamin B_1, one would need to consume 6½ kilos of National wheatmeal bread, ¾ kilo of commercial wheat germ or 90 gm. of dried brewers' yeast. One should consider, therefore, if these greatly increased demands for vitamins of the B complex do exist, and if they do, whether it would be possible for an athlete to obtain them from natural foods, with the possible exception of dried yeast. Perhaps, then, an athlete's performance is limited by his vitamin B complex intake, and this is itself limited by the amount of natural food he can eat. The consumption of quantities of meat, liver, eggs, etc., by athletes may be related not to the protein content of these foods, but to the relatively high amounts of various members of the vitamin B complex they contain.

If supplementation of athletes' diets is undertaken, it should be remembered that there is some evidence that certain vitamins may have a supra-physiological or pharmacodynamical action, which may or may not be related to their normal nutritional function. Inspection of the literature on the effects of supplementing the diet with various vitamins of the B complex shows no uniformity of results; but on the average there does seem to be a bias in favour of the beneficial effect of these vitamins on muscular exercise.

Attempts to show that extra doses of vitamin C increased resistance to fatigue have also been equivocal; but there seemed to be some evidence in favour of its use.

There is little doubt that deficiency of most vitamins seriously affects muscular effort; but the difficulty is in deciding just at what level of intake deficiency exists.

Dr. Bourne felt that the subject of nutrition of athletes, with its obsession with calories and proteins, is lagging considerably behind modern advances in nutritional science.

In the afternoon, Sir Adolphe Abrahams asked what indication there was for a high calorie diet for athletes, what foodstuffs should predominate in it, and thirdly, what part, if any, alcohol should play in the diet of athletes?

On the question of calories, Sir Adolphe said that the figures published of the calorie intake of athletes at the Berlin Olympiad in 1936, which were said to have been compiled from observations on 4,700 competitors, were extraordinary. They quoted a daily average intake of 800 gm. of meat, 150 gm. of sugar, 150 gm. of butter, 1–1½ litres of milk, vegetables and fruit *ad lib.*, making a grand total of 7,300 calories. Such an intake is really equivalent to the requirements of a 24-hr. walking race, or daily violent physical exercise of six hours duration. In fact, no athlete in training undertakes six hours violent physical exercise a day. Most athletes visit the track twice a day. The sprinter does a few bursts from the start and a run through of 150 yd. each time, and few of even the long-distance men do really hard work during their training period. Events such as the annual Oxford and Cambridge boat race only use up about 500 calories per man. Athletes, therefore, do not need vast quantities of food; but a generous diet is desirable from a psychological point of view.

Discussing the role of meat in the diet, Sir Adolphe pointed out that athletes who claimed to be vegetarians invariably consumed milk, cheese and eggs, containing animal protein. He felt that extra sugar is not of particular benefit to athletes. The men of to-day are not better physically than the men of fifty years ago, and Sir Adolphe felt that the explanation of improved records is partly due to improved technique and partly to the increasing growth of the cult of athleticism.

The final paper of the day was given by Dr. Nevil Leyton on "Some Practical Aspects of the Training of Athletes". Dr. Leyton made the important point of the difference in individual calorie requirements for the performance of the same task, and the difference in the times before events that individual athletes require to eat. The actual calories for the Oxford and Cambridge boat race may be as much as 600 per man; this figure may be compared with that for a Marathon race, when 2,000 calories may be used. A five-set tennis match may use 1,200 calories. In addition, the body may continue to expend energy at a higher rate than normal for 24–48 hours after the event. A good training diet should nourish the athlete adequately during this period and should include fruit and vegetables, the function of these being partly to provide vitamins. Some consideration must also be given to the possibility of assisting the athlete during the contest. A 20-min. all-out effort uses about an ounce of sugar. So a marathon runner may use nearly 5 oz. in a race. Four ounces of sugar may be absorbed from the gut in about two hours. Some benefit should accrue to performance if an athlete is given sugar an hour or two before an event. Even if calories can be provided in sufficient amounts, it is often difficult in Britain to-day to provide an athlete with just the food he feels he wants, and this may have an adverse psychological effect.

The day's discussions were ably summed up by the chairman, Prof. J. R. Marrack.

SHORTAGE OF SCIENTIFIC TEXT-BOOKS IN CAMBRIDGE

A SURVEY carried out in Cambridge during March–April among teaching staffs and booksellers shows that nearly half of the scientific books the average student is recommended to buy are not available for him to buy new. It also shows that American books cover 33 per cent of all books students are recommended to buy, as opposed to 10 per cent before the War.

Teachers from twelve scientific departments of the University supplied lists of recommended text-books and also indicated the annual number of students likely to require each book. 145 titles were listed in all, 97 being of British origin and 48 American. Some books were, of course, alternatives to others, but the 145 titles covered 128 separate 'topics'.

The availabilities of American and British books depend upon different factors and were, therefore, estimated by different methods. Booksellers stated that the *number* of American books demanded has approximately doubled since 1939, whereas their average *price* has risen by about 50 per cent. Thus the current demand is about 300 per cent by value of the pre-war demand. Since permitted imports are now 200 per cent by value of pre-war imports, it is estimated that approximately two-thirds or 67 per cent of the American books now required are available. In other words, a student requiring an American book has, on the average, a two-thirds chance of obtaining it; a particular student may, of course, do better than this, either by good luck or by his own efforts. The above estimate neglects the possibility that an American book is out of print. The number of such books is small, and, in any event, should affect neither the total imports of American books nor the average availability in Great Britain. Also, no account is taken of books imported as single copies direct from the United States to the British purchaser; this factor is not thought to be important so far as students are concerned.

With the co-operation of booksellers, the British books were classified as: (1) available for immediate sale; (2) reprinting or new edition in preparation; (3) out of print. The data thus obtained referred to a particular date (early April 1948); but it seems probable that the percentage availability of a large sample of books at any one time will give a fair measure of their average availability over a period, individual fluctuations cancelling one another out. In fact, the availability found for the particular date agreed with the booksellers' own independent impression of the general position. Further, unless major changes in policy occur, of which there is no indication, the estimates should also hold for the near future. The student may, of course, be able to get second-hand copies, but this factor also does not seem to be of major importance, especially since students now finishing their courses are stated to have a greater tendency than formerly to keep their books. The data obtained refer to a wide range of subjects, but analysis showed that the position is not significantly different as between (1) physical and biological sciences, (2) books required by a large number of students (more than fifty copies a year) and those required by fewer.

Of the 128 'topics' analysed, 55 were available in British books. 48 were unavailable in British books and no American alternative was mentioned (of the 48 'topics', 33 books were reprinting and 15 were out of print). For the remaining 25 'topics', only American books were in print and it was assumed that 17 of these were actually available and 8 not available (that is, a 67 per cent availability as stated in a previous paragraph). Hence only 72 (55 plus 17) out of the 128 'topics' were available in any form, that is, 56 per cent.

As stated above, 97 of the 145 titles were British, and 56 per cent of these were available. It will be noted that this compares unfavourably with the percentage availability of American books (67 per cent). It is of further interest that about 50 per cent of the American books were listed as alternatives to British books, and about 20 per cent of the British books were given with American alternatives. Both booksellers and teachers confirmed that the demand for American books has considerably increased since before the War and now represents about 33 per cent of the total demand, as opposed to 10 per cent before the War.

The survey comments that the advantage that American books have over their approximate British alternatives is due primarily to the paper shortage and other obstacles to British book production, coupled with the lack of priority as to subject-matter in the allocation of paper to British publishers. This lack of discrimination at home stands in marked contrast to the complete discrimination in favour of learned, scientific and technical books when imported from abroad. The supplies of British text-books are affected both by low production and high export. Out of a total value of more than £30 million for books of all types produced in Britain in 1947, 24·5 per cent was exported (*The Bookseller*, March 20, 1948). The proportion of British book production (all types) exported was as high as 35 per cent in 1940 and 29 per cent in 1941 (*The Bookseller*, March 20, 1948). The much-enhanced position of American scientific books in the British market dates from that time. It has not been seriously affected by the short period in which imports were cut to 100 per cent of pre-war value. American publishers are continuing to press their advantage, arising from Britain's production difficulties and her need to export.

Many of the newer American books are, of course, invaluable, and no British alternative exists. This is especially true of up-to-date scientific and technological works of reference. In this respect American books have an advantage over British ones, quite apart from Britain's immediate production difficulties and need to export. In great part, of course, the advantage arises from the larger scale of American industrial and scientific activity generally, and hence the greater number and variety of specially qualified authors. Nevertheless, there are other, less unavoidable, reasons for the relative paucity of new British advanced works. Delays in publication put British books at a disadvantage by increasing the chances that a new American book will have arrived and satisfied the demand in a subject before an already-written British book on that subject appears. Furthermore, inquiries in Cambridge indicate that new British works are not being *written* in numbers commensurate with our supply of qualified authors. An important deterrent mentioned was lack of time and (not so important) lack of financial inducement. Increased teaching pressure leaves little time for the writing of new books and makes it difficult for those who fell behind in their reading while on war-work to catch up again. The direct financial inducement to write advanced scientific works was never great; but to-day it is smaller than ever. Publishers try to share out their limited paper among the most needed titles, and the consequent small impressions mean correspondingly small royalties. The survey suggests that official encouragement should be given to the writing of new books by British specialists.

It is stated that a good case can be made out for the large percentage of book production which goes to export. It is emphasized, however, that this trade and, even more important, this reputation, are in danger unless our total volume of 'learned, scientific and technical' book production is increased both in number of copies of existing standard works and in new titles. The value of American exports of books (all types) to all countries had not in 1947 quite equalled Britain's; but 1947 was the year in which the import of America's books was artificially restricted by two of her best customers, Britain and Australia. In spite of that, American exports rose more steeply than our own. With British import restrictions relieved, American exports may be expected to surpass Britain's. Moreover, America can, as Britain cannot, increase the exported fraction of her total production without serious consequences for the home consumer. America's exported fraction was only 7 per cent of the total (in 1946) as against Britain's 25 per cent. The conclusion is drawn that it is essential that British scientific book production should be increased by giving priority in material allocation to the publication of such books, so that both the home and export markets may be better supplied.

This survey was carried out by the Cambridge Branch of the Association of Scientific Workers, and copies of the complete survey are available from the Head Office of the Association (15 Half Moon Street, Piccadilly, London, W.1). R. INNES

NEWS and VIEWS

Physiology at the London Hospital Medical College: Dr. John L. D'Silva

DR. JOHN L. D'SILVA, reader in physiology at St. Bartholomew's Hospital Medical College, who has been appointed to the chair of physiology at the London Hospital Medical College, was born and educated in southern India. He graduated with first-class honours in chemistry at King's College, London, in 1929, and remained there for a further three years doing research on the chemistry of disulphides. In 1932 he went over to physiology, still at King's College, carrying out investigations on the effect of adrenaline on the metabolism of potassium. After a short period with Messrs. British Drug Houses, Ltd., spent on research into the molecular distillation of fish oils in connexion with the study of vitamin A, he went in 1936 to St. Bartholomew's Hospital Medical College, where he was demonstrator in physiology and in biochemistry, and continued his work on the metabolism of adrenaline and potassium. He was awarded the degree of D.Sc. for his published work. During the Second World War, Dr. D'Silva qualified as a medical practitioner and also continued teaching. After work at St. Bartholomew's Hospital, in 1944 Dr. D'Silva was appointed to the Medical College again and has remained there since, lecturing and carrying out research on the physiology of the visual process.

Jöns Jakob Berzelius (1779–1848)

WHEN he died a century ago on August 7, 1848, Berzelius was not only the most famous chemist of the world, but also the autocrat of the world of chemistry. The son of a schoolmaster, he was born near Linköping on August 29, 1779. After studying medicine and chemistry at Uppsala, at the age of twenty-three he was appointed assistant professor of botany and pharmacy at Stockholm, and full professor in 1807. During 1815–32 he held the chair of chemistry in the Caroline Medico-Chirurgical Institution. In 1818 he became perpetual secretary of the Stockholm Academy of Sciences, and received a title of nobility, with permission to retain his name. Seventeen years later, on the occasion of his marriage, he was made *Freiherr*. Berzelius spent some ten years determining with great accuracy the atomic and molecular weights of more than two thousand chemical substances; he isolated selenium, thorium, silicon, titanium and zirconium, and also prepared and examined many organic compounds. He devised the present system of chemical symbols. His "Lehrbuch der Chemie", begun in 1808, went through five editions and, in various translations, spread his fame over Europe. His dualistic electrochemical theory exerted a profound influence on the progress of chemistry. Though Berzelius worked in the simplest of laboratories, his reputation attracted students from many countries. In his hands the blow-pipe became the symbol of qualitative dry analysis. Distinguished in appearance, inclined to be portly, neat in attire and habits, cordial and unassuming, Berzelius was vigorous in body and mind, though essentially conservative in his outlook. Of his characteristic sayings the following may serve as a sample: "The devil may write text-books of chemistry, for every few years the whole thing changes".

Australian Journal of Scientific Research

THE Australian Council for Scientific and Industrial Research, in collaboration with the Australian National Research Council, has decided to take responsibility for the establishment in Australia of a new scientific journal, the *Australian Journal of Scientific Research,* as a medium for the publication of research papers of outstanding merit. This journal is open to receive contributions from research workers, irrespective of country or of the organisation to which they are attached. Dr. N. S. Noble has been appointed as editor of the new journal. Editorial policy will be determined by an editorial board under the chairmanship of the editor and comprising as members: Prof. W. J. Dakin (Department of Zoology, University of Sydney), Prof. E. J. Hartung (Department of Chemistry, University of Melbourne), Prof. L. H. Martin (Department of Physics, University of Melbourne), and Prof. J. G. Wood (Department of Botany, University of Adelaide). The Board aims at achieving a high standard of quality in papers accepted and a strict refereeing system has been instituted. The *Journal* will be printed in two series: Series A (Physical Sciences) and Series B (Biological Sciences). Initially each series will be issued quarterly and will cost 30*s.* a year.

Birkbeck College Research Laboratory

By the aid of a gift from the Nuffield Foundation, Birkbeck College (University of London) has been enabled to equip and staff two houses in Torrington Square, London, W.C.1, as a Biomolecular Research Laboratory under the direction of Prof. J. D. Bernal. The main work of the Laboratory will be the application of physical methods, particularly X-ray analysis, to the understanding of the structures and reactions of molecules in biological systems. X-ray methods are being used in two ways, namely, the study of the mutual relations in space of virus molecules in solution and in solid phases by low-angle diffraction; and the investigation of the internal structure of the molecules themselves by high-angle diffraction. In addition to the study of molecules directly connected with proteins, others of more general biological interest are also being examined by modern X-ray analytical methods, as well as other structures chosen to develop methods of X-ray crystal analysis. To make the fullest use of existing techniques and to develop further experimental and theoretical tools for this purpose, two sections devoted to electronics and computation respectively have been added to the Laboratory. The design has already been completed of an electronic computing machine of such speed that complete analysis of complex structures by the method of 'steepest descents' can be carried out in a reasonable time. Another section of the Laboratory is working on the fundamental structure of the active constituents of Portland cement, and the nature of their reaction with water; this investigation is being financed by the Department of Scientific and Industrial Research. The work is not so isolated from the main interests of the Laboratory as may at first sight appear; for already it has been found that the properties of hydrated cements are closely related to those of many biological gels and are strongly influenced by the same long-range forces. Part of the two houses now taken over by Birkbeck College to provide for these investigations is being devoted to chemical research under Prof. W. Wardlaw and will also furnish facilities for chemical work in connexion with the biomolecular studies.

The new Laboratory was formally opened by Sir Lawrence Bragg on July 1. Sir Lawrence welcomed the initiation of a new Laboratory which is to study biomolecular substances, because such borderline subjects between physics, chemistry and biology are becoming so very important. There is always a difficulty in attracting first-rate young research workers into borderline subjects, because they tend to classify themselves as physicists, chemists or biologists and take up research accordingly. Probably the best way of overcoming this difficulty would be to provide first-rate centres of research, directed by well-known scientific workers, for such subjects.

Rubber Technology Conference

Elsewhere in this issue (p. 204) an account is given of some physical and chemical aspects of the contributions to the Rubber Technology Conference held in London during July 23–25. The Conference was attended by no less than 609 members, including 119 from abroad. This compared very favourably with the previous Conference in 1938, when 553 members attended. On the occasion of the 1938 Conference more than a hundred papers were presented, and this necessitated two simultaneous sessions. This year there were only forty-three papers spread over eight sessions running consecutively. An outstanding feature of the Conference was a demonstration of physical and chemical properties of rubber on June 23 arranged by Mr. E. F. Powell and certain members of his staff from the Dunlop Rubber Co., Ltd. The Conference closed with a dinner at the Connaught Rooms, London, on the evening of June 25; Mr. F. D. Ascoli, president of the Institution of the Rubber Industry, presided. During the evening, the Colwyn Medal of the Institution was presented to Dr. R. P. Dinsmore of the Goodyear Tyre and Rubber Co. of the United States. This is the sixteenth award of the Medal and the first time that it has gone to an American.

Earthquakes during May

During May ten strong earthquakes were registered at observatories throughout the world, and there were numerous smaller shocks and tremors. The greatest earthquake which was registered at Kew gave ground amplitudes of 110 μ at Kew on May 14 and came from a focus the epicentre of which was south of the Alaska Peninsula (lat. 54½° N., long. 161° W.). A world-shaking aftershock of this came on May 17 from a focus the epicentre of which was perhaps slightly to the north of the original. The second most intense shock of the month was the one which occurred on May 11, starting from a focus with epicentre near lat. 17° S., long 71° W. in southern Peru. The focus of this earthquake was a little deeper than normal; the instrumental strength of the shock was almost 7½, and casualties and damage were caused at Moquegua in southern Peru and at Arica and Tacua in northern Chile. The third greatest earthquake shock of the month happened on May 25 from a focus having an epicentre near lat 30° N., long. 99½ E. in Sikang Province in China. A much less intense earthquake on May 28 from a focus with epicentre at lat. 12° S., long. 77° W. did damage to property and caused the deaths of five people in Peru. The deepest focus earthquake of the month occurred on May 23 from a focus some 200 km. deep with epicentre near lat. 18° S., long. 169° E. More feeble shocks occurred on May 23, doing damage to property in both islands of New Zealand; on the morning of May 24, throwing people out of bed at Palermo in Sicily; and on May 25, off the west coast of Oregon. Data for the month have been received from the U.S. Coast and Geodetic Survey, the International Seismological Bureau at Strasbourg, and observatories at Beograd, De Bilt, Durham, Kew, Stuttgart, Toledo and Uccle.

Cleveland Seismological Observatory

In 1946 gifts from the Louis D. Beaumont Trust and the Cleveland Foundation financed the purchase of three electromagnetic seismographs of the Sprengnether type for the Cleveland Seismological Observatory, which is situated at lat. 41° 29′ 27·90″ N., long. 81° 31′ 52·22″ W. (geographic co-ordinates) at an altitude of 1,070 ft. on University Heights, Cleveland, Ohio. The geocentric latitude is 41° 18′ N. The staff at present consists of the Rev. Henry F. Birkenhauer, *S.J.* (director), Rev. Joseph S. Joliat, *S.J.* (associate director), Dr. Edward J. Walter (assistant director), Mr. Richard Becka and Miss Jeanne Carrabine. The publication of monthly teleseismic bulletins and monthly microseismic reports has already begun.

New Tropical Fungi

The various regions of Central Africa are a territory which has not been studied mycologically in any detail. It is therefore not surprising that, in a second paper on tropical fungi, G. B. Hansford (*Trans. Linn. Soc. Lond.*, 159, pt. 1, pp. 21; 1947), in describing thirty-four species, includes no less than twenty-eight new ones. The genus *Meliola* is well represented with eight new species, and it has been found necessary to create two new genera, *Phragmodiscus* and *Dictyoasterina*, to accommodate some of the new findings. The collections are from Uganda, the Belgian Congo and Sierra Leone.

University of Leeds

The Council of the University of Leeds has announced that the Wool Industries Surplus Cloth Corporation, Ltd., has given a sum of £40,500 for the establishment in the University of a research chair of wool textile engineering within the Department of Textile Industries. Other gifts include £10,000 from the International Wool Secretariat (in addition to a similar amount already received) for the purpose of completing the cost of equipping the new Wool Research Laboratories; 1,000 dollars from the Ella Sachs Plotz Foundation for the purchase of equipment for the Department of Biochemistry; £250 from Messrs. J. and J. Crombie of Aberdeen, for the Textile Department; £2,126, handed over by the Leeds Public Dispensary and Hospital, being the balance of the Research Appeal Account, which the Council agreed to earmark for rheumatism research; £300 a year from Sandoz Products, Ltd., of Bradford, to provide a scholarship for a male candidate to take the form of three consecutive two-year awards; 500–600 plastic mouldings for experimental research in speech training, presented to the Department of Education by Messrs. Birkby's, Ltd., of Liversedge.

University of London: Appointments

The following appointments in the University of London have been announced: Dr. D. V. Glass, reader in demography at the London School of Economics and Political Science, to the University chair of sociology tenable at the School; Mr. E. P. Sharpey-Schafer, physician and senior lecturer at the Postgraduate Medical School of London, to the University chair of medicine tenable at St. Thomas's Hospital Medical School; Dr. D. S. Bertram, lecturer in the Department of Entomology and Parasitology in the Liverpool School of Tropical Medicine, to the University readership in entomology tenable at the London School of Hygiene and Tropical Medicine; Dr. F. L. Warren, senior lecturer in biochemistry in the Physiology Department of St. Mary's Hospital Medical School, to the University readership in biochemistry tenable at University College. All these appointments take effect on October 1, 1948.

The titles of emeritus professor in the University have been conferred on the following: Prof. A. B. Appleton, on his retirement from the chair of anatomy at St. Thomas's Hospital Medical School; Prof. O. L. V. de Wesselow, on his retirement from the chair of medicine at St. Thomas's Hospital Medical School; Prof. F. E. Fritsch, on his retirement from the chair of botany at Queen Mary College; Prof. D. T. Harris, on his retirement from the chair of physiology at the London Hospital Medical College; Prof. T. Baillie Johnston, on his retirement from the chair of anatomy at Guy's Hospital Medical School; Prof. W. Neilson Jones, on his retirement from the Hildred Carlile chair of botany at Bedford College.

The following doctorates have been conferred: D.Sc.: J. R. Busvine (Imperial College of Science and Technology); D.Sc.(Eng.): D. G. Tucker (external student).

Beit Memorial Fellowships for Medical Research

The following elections have been made by the Beit Memorial Trustees: *Senior Fellowship* (£900 a year): Dr. F. Sanger (Cambridge), to study the structure of proteins with special reference to insulin, at the Department of Biochemistry, University of Cambridge. *Junior Fellowships* (normal value £600 a year): D. A. Darcy (Dalhousie, Canada), to study the role of the lymphocyte and plasma cell in homograft breakdown, at the Department of Zoology and Comparative Anatomy, Oxford; R. M. C. Dawson (London), to study biochemical changes in the brain associated with different forms of functional activity, at the Biochemical Laboratories, Cardiff City Mental Hospital; F. N. Fastier (New Zealand), to study the nature of the musculotropic action of basic amidine derivatives, at the Department of Pharmacology, Oxford; Dr. L. J. Haynes (London), to study the synthesis of the coenzyme, cozymase, at the University Chemical Laboratory, Cambridge; Dr. A. T. James (London), to study the relationship between structure and biological activity in naturally occurring substances, at the Lister Institute of Preventive Medicine, London; A. McCoubrey (London), to study analgesic and addictive tendencies from a chemical point of view, at the Departments of Organic Chemistry and Pharmacology, University of Leeds; S. W. Stanbury (Manchester), to study the effect of changes in nervous activity, induced by narcosis and sleep, on the renal circulation and blood pressure in normal and hypertensive individuals, at the Department of Medicine, University of Manchester; D. Verel (Cambridge), to study the postural hypotension which may follow prolonged rest in bed, at the Clinical Research Unit, Guy's Hospital, London.

Announcements

The Joint Committee consisting of representatives from the Royal Society of Edinburgh, the Royal Physical Society, and the Royal Scottish Geographical Society have awarded the Dr. W. S. Bruce Memorial Prize to Dr. W. A. Deer, Department of Mineralogy and Petrology, University of Cambridge, for his work in East Greenland during 1935–36, especially in regard to the petrology of the Skaergaard gabbro intrusion.

The Faraday Society is arranging a general discussion on "The Physical Chemistry of Process Metallurgy" to be held at Ashorne Hill, near Leamington Spa, by permission of the British Iron and Steel Federation, during September 23–25. Further particulars can be obtained from the Secretary, Faraday Society, 6 Gray's Inn Square, London, W.C.1.

The postgraduate lectures for 1948 of the London Section of the Oil and Colour Chemists' Association will be delivered by Prof. H. J. Emeléus, on September 30, October 7 and 14 at 6.30 p.m., at the Royal Institution. Prof. Emeléus will speak on "The Impact of Radioactivity on Inorganic Chemistry". Admission will be by ticket (price 10*s.*) obtainable from the honorary secretary of the London Section of the Association, H. C. Worsdall, c/o Messrs. Plastanol, Ltd., Crabtree Manorway, Belvedere, Kent.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Properties of a Hypothetical di-Neutron

THE question of the possibility of obtaining experimental evidence for the existence of a neutral particle of mass 2 has recently been raised by Kundu and Pool[1]. These authors suggest that certain features of nuclear transformations produced by bombardment by tritium (^{3}H) ions favour the conclusion that a di-neutron having at least transient existence may be captured as a single entity in a nuclear process of an Oppenheimer – Phillips type.

It is the object of this note to point out that the β-active species ^{6}He, though stable against the spontaneous emission of neutrons of normal mass (stable, that is, against the process $^{6}\mathrm{He} \rightarrow {}^{5}\mathrm{He} + {}^{1}n$), is unstable against the emission of a di-neutron which has more than a relatively small energy of binding, so that the presumption that a di-neutron is not, in fact, emitted by ^{6}He (based on the evidence of its 'long' life-time) sets an upper limit to the binding energy of this hypothetical particle. In deducing this limiting energy, we may consider the reactions :

$$^{9}\mathrm{Be}\ (+\ h\nu) \rightarrow {}^{8}\mathrm{Be} + {}^{1}n + Q_1$$

$$^{8}\mathrm{Be} \rightarrow 2\,{}^{4}\mathrm{He} + Q_2$$

$$^{9}\mathrm{Be} + {}^{1}n \rightarrow {}^{6}\mathrm{He} + {}^{4}\mathrm{He} + Q_3.$$

Obviously we have

$$^{6}\mathrm{He} \rightarrow {}^{4}\mathrm{He} + 2\,{}^{1}n + Q_1 + Q_2 - Q_3\,;$$

and inserting experimental values, $Q_1 = -1{\cdot}63$ MeV.[2], $Q_2 = 0{\cdot}12$ MeV.[3], $Q_3 = -\ 0{\cdot}8$ MeV.[4], we obtain

$$^{6}\mathrm{He} \rightarrow {}^{4}\mathrm{He} + 2\,{}^{1}n - 0{\cdot}7\ \mathrm{MeV}.$$

This last figure ($0{\cdot}7 \pm 0{\cdot}2$ MeV.) is the upper limit to the binding energy in question—a very much smaller binding energy than that of the deuteron (2·17 MeV.).

In terms of these last two binding energies, we can proceed to set limits to the energy available for the β-disintegration of a quasi-stable di-neutron ($^{2}_{0}n$). Clearly we have

$$^{2}n - {}^{2}\mathrm{H} + Q_4 = {}^{1}n - {}^{1}\mathrm{H} + 2{\cdot}17\ \mathrm{MeV}.\,;$$

where $^{1}n - {}^{1}\mathrm{H} = 0{\cdot}76$ MeV. and, as above obtained, $0 < Q_4 < (0{\cdot}7 \pm 0{\cdot}2)$ MeV. Thus $(2{\cdot}2 \pm 0{\cdot}2) < ({}^{2}n - {}^{2}\mathrm{H}) < 2{\cdot}93$ MeV. This estimate allows us to predict the life-time (τ) of the di-neutron on the reasonable assumption that the transition

$$^{2}n \xrightarrow{\beta} {}^{2}\mathrm{H}$$

is super-allowed[5]. In this way we obtain $1 < \tau < 5$ sec.

From the fact that ^{6}He is sufficiently long-lived to exhibit β-activity, we have thus deduced quite narrow limits for the radioactive constants of the hypothetical di-neutron. It might be added that, if such a particle should exist, it would be expected to be produced in (^{1}n, ^{2}n) reactions over a small range of neutron bombarding energy, in each case just below the absolute threshold energy for the corresponding (n, $2n$) reaction—and even at energies somewhat above these absolute thresholds, because of the requirement that the first neutron emitted in an (n, $2n$) process shall be emitted with finite energy. But, above all, search for the di-neutron might most conveniently begin with beryllium under neutron bombardment, not only because the (n, $2n$) threshold is lowest with this element (which makes possible the use of a D—D neutron source, which is free from γ-radiation), but also because the possibility of producing ^{6}He in an excited state in this case opens the further possibility (see above) that the di-neutron may be obtained as a secondary disintegration particle following upon the reaction ^{9}Be (^{1}n, ^{4}He) ^{6}He*. This possibility is unique just because the mass number 5 is the only mass number for which a neutron-stable species does not exist ; thus the excitation necessary to render ^{6}He unstable against the successive emission of two neutrons of normal mass is correspondingly increased.

As regards possible methods of detecting a di-neutron, it is perhaps out of place in this note to offer detailed suggestions. But apart from its spontaneous radioactivity (the half-value period of which is reasonably short) a quasi-stable di-neutron might be expected to produce nuclear transformations which in certain cases might be sufficiently characteristic to be used for its identification. Thus activities might be induced in effectively simple elements (such as ^{6}He in helium, ^{25}Na in sodium, ^{105}Rh in rhodium, ^{211}AcC in bismuth, for example) for some of which large capture cross-sections might apply. It might even be possible, investigating suitable substances under deuteron or α-particle bombardment at energies in the neighbourhood of the (d, $2n$) or (α, $2n$) thresholds, to work under conditions in which the flux of di-neutrons was comparable with the normal neutron flux. In such circumstances comparison of the pulse-size distributions due to the recoil particles in hydrogen- and deuterium-filled ionization chambers might be used to effect a clear-cut identification.

N. FEATHER

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June 15.

[1] Kundu and Pool, *Phys. Rev.*, 73, 22 (1948).

[2] Myers and Van Atta, *Phys. Rev.*, 61, 19 (1942). Wiedenbeck and Marhoefer, *Phys. Rev.*, 67, 54 (1945).

[3] Hemmendinger, *Phys. Rev.*, 73, 806 (1948).

[4] Allen, Burcham and Wilkinson, *Proc. Roy. Soc.*, A, 192, 114 (1947).

[5] Feather and Richardson, *Proc. Phys. Soc.*, in the course of publication.

Propagation of Pulses of Second Sound in Liquid Helium II

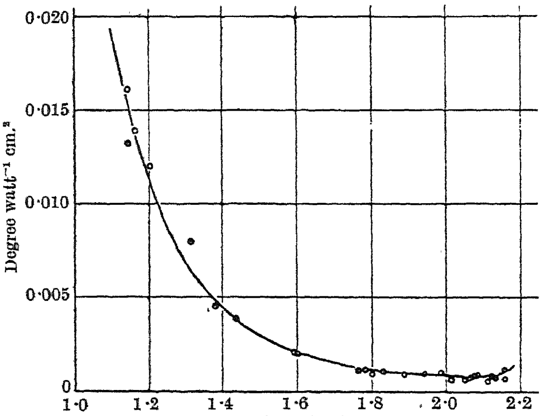
PRELIMINARY measurements of the velocity of second sound in this Laboratory using a resonator of fixed length and signals of a variable frequency have given results in good agreement with the resonance measurements of Peshkov[1] and of Lane, Fairbank and Fairbank[2]. In the course of these experiments it became apparent that if measurements were to be extended below 1° K., some method would be necessary which used a smaller mean power input. It can be shown, too, that the amplitude of temperature oscillation obtained in a resonance experiment is governed entirely by damping, and provides little information about the propagation of travelling waves in the medium.

With these considerations in view, a technique has been developed for transmitting and receiving pulses of second sound. The signals are generated by applying a direct current pulse of 0·1–1 millisecond duration to a fine wire heater. The second sound pulse travels down an ebonite tube about 5 cm. long filled with liquid helium II, and is received by a phosphor bronze resistance thermometer which carries a steady direct current. The change of resistance causes a voltage pulse to appear across the thermometer and, after suitable amplification, this is displayed on a cathode ray tube. Using standard radar techniques, it is a simple matter to time the pulse on its journey and hence to measure its velocity. The velocity results, which cover the range 1·1°–2·16° K., are in good agreement with those of earlier workers using the resonance method, and need not be reproduced here.

The more interesting feature of this method is the information which it provides about temperature amplitudes. It can be shown very simply, by considering the propagation of a unit step of temperature, that the power flow per unit area, W_1, must be connected with the temperature amplitude, T_1, by the relation

$$\frac{T_1}{W_1} = \frac{1}{\rho c u_2},$$

where ρc is the specific heat per unit volume of liquid helium and u_2 is the velocity of second sound. This relation is independent of any special theory of second sound and assumes only the propagation of a unit step without change of shape. The temperature amplitude ($\sim 10^{-3}$ ° K.) can be deduced experimentally from the size of the output signal, the gain of the amplifier and the calibration of the thermometer wire. The power fed in during the pulse ($\sim 0 \cdot 1$ watt cm.$^{-2}$) can be deduced from measurements of the voltage applied to the heater and of the heater resistance. The full line in the accompanying diagram gives $1/\rho c u_2$ (calculated from the known values of ρc and u_2) as a function of temperature, while the points are the experimental values of T_1/W_1. The agreement is well within experimental error.



Curve plotted from values of $1/\rho c u_2$; experimental points, values of T_1/W_1

Experiments are in hand to study the possible dispersion and absorption of second sound and to extend the velocity measurements to the range below 1° K. A combination of such velocity measurements with amplitude measurements may, on the basis of the above equation, provide a convenient method of determining the specific heat of liquid helium below 1° K.

D. V. Osborne

Royal Society Mond Laboratory,
Cambridge.
June 22.

[1] Peshkov, V., Phys. Soc. Camb. Conf., 19 (1946).

[2] Lane, C. T., Fairbank, H. A., and Fairbank, W. M., *Phys. Rev.*, 71, 600 (1947).

Emission Schumann – Runge O_2 Bands

Following on a recent contribution in *Nature*[1], it seems desirable to report briefly some work carried out in this laboratory and shortly to be published elsewhere in detail. Lalji Lal[1] has produced the Schumann – Runge bands of O_2 from 2450 A. to 4490 A. using a high-frequency discharge. He reports new bands which he has identified from small glass and quartz spectrograms.

I have photographed the Schumann – Runge system from 2000 A. to 5000 A. on a quartz Littrow (Hilger *E*.1) spectrograph, and this dispersion has been found sufficient for adequate resolution of the rotational structure of the bands. The spectra were excited by a high-voltage low-current arc in oxygen at atmospheric pressure. This source emits the bands so well that they occur even when the arc chamber is filled with air. In addition to the bands measured by earlier workers, the following bands have been found: (2, 22), (1, 12), (0, 11), (1, 11), (0, 10), (1, 10), (2, 10), (0, 9), (1, 9), (2, 9), (1, 8), (2, 8), (2, 7), (3, 7), (2, 6), (3, 6), (3, 5). Though some of these bands fall in the region investigated by Lalji Lal, his analysis does not correspond to that given here. However, bands of high v' will be more easily excited in the low-pressure source since collision damping will be active at high pressures, and this may account for some of the differences. The present analysis seems to give the Franck – Condon parabola suggested by previous work, whereas Lalji Lal's bands are rather widely scattered in the v' v'' array.

On comparing Lalji Lal's wave-numbers with those calculated from the data of previous workers, some rather large discrepancies are found. An attempt was made to identify Lalji Lal's bands both on *E*.1 and small quartz (*E*.3) spectrograms, but no good coincidences were found; the same result was obtained when examining the *E*.2 photograph obtained by Wulf and Melvin[2]. Obviously the difficulty can only be removed either by photographing the high-frequency discharge at larger dispersion for a more accurate analysis or by direct comparison of high-frequency discharge and high-voltage arc spectrograms. The heads are so weak on the present spectra that analysis has been made by identification of the rotational structure of each band, and 'heads' that seem present with small dispersion are found, with higher dispersion, to be merely due to chance overlapping of structure from several bands.

It will be seen that the present interpretation of the bands shows that Flory's[3] suggestion of predissociation for $v' > 2$ is incorrect (this also follows from Lalji Lal's analysis). In the detailed publication referred to above, Flory's arguments are critically examined, and it is found that there is no difficulty in abandoning the predissociation hypothesis.

The bands are found to be very sensitive to pressure changes and are strongly emitted only at a pressure near atmospheric, unless specially pure gas is used to allow long exposures without the appearance of impurity spectra. This may be explained by the fact that normal O_2 molecules are dissociated by electronic collisions into $O(^3P)$ and $O(^1D)$ atoms, since a Frank – Condon transition from the ground-state ($^3\Sigma_g^-$) leads to a molecule in the $^3\Sigma_u^-$ state which is excited 3·5 volts above the dissociation limit of this state. For the emission of a band system, recombination to the excited state must occur, and this becomes more probable at high pressures where rapid diffusion is prevented. Results obtained by various authors using high-voltage arcs, ozonizers and glow discharges all support this result.

These investigations were undertaken in connexion with work in progress here on the spectrum of the night sky, and from the spectra measurements are being made which will enable the O_2 Herzberg bands, believed present in the night sky spectrum, to be more accurately predicted than previously.

I am indebted to Prof. R. W. B. Pearse for suggesting the work and for his constant advice.

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A Simple Result in Quadrature

IN calculating the intensity of light scattered by a transparent homogeneous medium, one comes across the infinite series[1]

$$\alpha \sum_{n=-\infty}^{+\infty} \frac{\sin^2 (n\alpha + \theta)}{(n\alpha + \theta)^2}, \tag{1}$$

in which θ is a constant and n an integer. α is a positive number, which under the conditions under which light-scattering is generally studied is very small, and hence the sum of the above series is usually replaced by the corresponding integral

$$\int_{-\infty}^{+\infty} \frac{\sin^2 x}{x^2}\, dx, \tag{2}$$

which evidently is equal to π.

It can be shown[1], however, that the equality of (1) and (2) holds not only in the limit when $\alpha \to 0$, but for any value of α in the range $0 < \alpha \leqslant \pi$. An obvious interpretation of this result is that the area subtended between the curve $y = \sin^2 x/x^2$ and the x-axis can be obtained by taking the sum of the ordinates at equal intervals α, $0 < \alpha \leqslant \pi$, and multiplying by α, that is, by simple rectangulation, just as well as by integration. In erecting these ordinates at equal intervals, we may start from any value θ of x.

The main purpose of this note is to direct attention to this property, namely,

$$\alpha \sum_{n=-\infty}^{+\infty} f(n\alpha + \theta) = \alpha \sum_{n=-\infty}^{+\infty} f(n\alpha) = \int_{-\infty}^{+\infty} f(x)\, dx, \tag{3}$$

where $0 < \alpha \leqslant$ a certain constant α_0, which characterizes $f(x) = \sin^2 x/x^2$, and to show that numerous other functions can be constructed that have this property. A method of evaluating (1) given by Prof. Wiener, and quoted in the paper referred to[1], suggests the criterion by which to construct such functions.

Consider an even function $F(x)$ [$= F(-x)$] the Fourier transform of which,

$$g(v) = \frac{1}{\sqrt{(2\pi)}} \int_{-\infty}^{+\infty} F(x) \exp\,(ivx)dx, \tag{4}$$

has non-zero values when $| v |$ is less than a certain constant v_0, and is zero otherwise. Then by Poisson's summation formula[2]

$$\alpha \sum_{n=-\infty}^{+\infty} F(n\alpha + \theta) = \sqrt{(2\pi)} \sum_{N=-\infty}^{+\infty} \exp\,[-i2\pi N\theta/\alpha].\; g(2\pi N/\alpha), \tag{5}$$

where n and N are integers and $\alpha > 0$. If now α is chosen to be $\leqslant 2\pi/v_0$, then all the terms on the right-hand side of (5) except the one corresponding to $N = 0$ vanish, and we obtain

$$\alpha \sum_{n=-\infty}^{+\infty} F(n\alpha + \theta) = \sqrt{(2\pi)}\, g\,(0),$$

which can be seen from (4) to be equal to $\int_{-\infty}^{+\infty} F(x)\, dx$; and hence the function F satisfies (3).

Since the Fourier integrals of a large number of functions have been tabulated by Campbell and Foster[3] and by others, it is easy to select, or construct, examples of functions F the Fourier transforms of which satisfy the above criterion, and which satisfy (3). $F(x) = \sin^m x/x^n$, where m and n are positive integers, $m \geqslant n$, both of them odd or both of them even, is one such function with $v_0 = m$; when $m = 1$, the range of v over which $g(v) \neq 0$ includes $v = 1$. A few other examples are given below.

$F(x)$	$\sqrt{(2\pi)}\,.\,g(v)$	v_0
$\dfrac{\sin\,[a(x^2 + \lambda^2)^{1/2}]}{(x^2 + \lambda^2)^{1/2}}$	$\pi\, J_0\, [\lambda(a^2 - v^2)^{1/2}]$	a
$\cos\,[a(x^2 + \lambda^2)^{1/2}] - \cos ax$	$-\dfrac{\pi a\lambda J_1\, [\lambda(a^2 - v^2)^{1/2}]}{(a^2 - v^2)^{1/2}}$	a
$\dfrac{1}{\Gamma(a + x)\, \Gamma(\beta - x)}$	$\dfrac{(2 \cos 1/2v)^{\alpha + \beta - 2} \{ -\frac{1}{2} \exp iv(\alpha - \beta)\}}{\Gamma(\alpha + \beta - 1)}$	π[4]

A more detailed account will be published shortly in the *Journal of the Indian Mathematical Society*.

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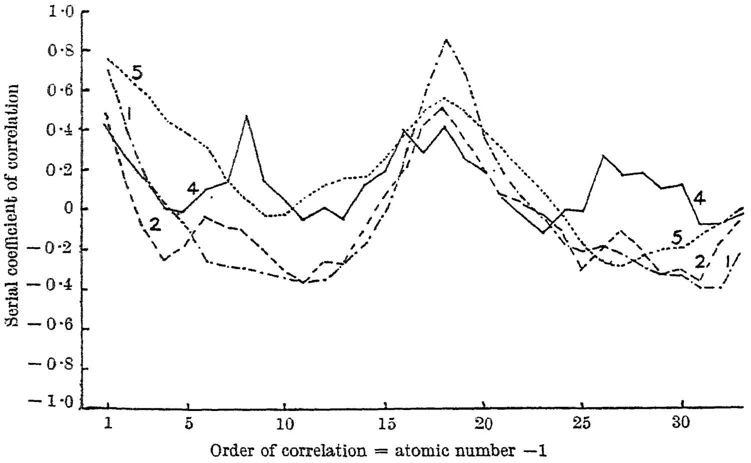
Physical Periodicity of the Periodic Table of the Elements in the Light of Statistical Theory

THE periodic system of the elements, arrived at originally from the collation of facts of a chemical nature, has since been most strikingly reflected by most of the physical properties of the elements. The melting points, boiling points, coefficients of thermal expansion, atomic volumes, compressibilities, densities, ionization potentials, to mention only a few properties, undergo periodic variations with increasing atomic weight or atomic number.



1, Atomic volumes; 2, melting points; 4, ionization potentials; 5, densities

It seemed of interest to inquire whether the generating mechanism of the physical periodicity was the same for all the physical properties to which it applied, or whether there existed characteristic differences between the periodicities of different physical properties. With the view of obtaining an answer to that question, some of the series were subjected to the statistical analysis called correlogram analysis[1]. The correlogram is the plot of the serial correlation coefficient against the order of correlation. For example, in the correlogram for atomic volume, the points are the correlation coefficients between the series of atomic volumes 1, 2, 3 . . . *n* times apart in the series of the elements arranged according to their atomic numbers, plotted against the atomic number minus one.

The series subjected to the analysis were those of the atomic volumes (1), melting points (2), compressibilities (3), ionization potentials (4) and densities (5) of the first sixty elements. Series 1 to 4 are based upon Tables 2 and 16, Chapter 5 of "Physical Chemistry" by E. A. Moelwyn-Hughes; Series 5 is taken from Table 3, "Physical Chemistry" by Gucker-Meldrum, based upon the International Critical Tables, supplemented by Landolt-Börnstein tables. The first thirty-three serial correlation coefficients were calculated and plotted against the order of correlation; the curve for compressibilities has been left out of the diagram so as to avoid overcrowding.

On the basis of the correlogram it appears that what was hitherto called 'physical periodicity' has a different structure, that is, it represents sums of different cyclical components, for each of the physical characteristics under investigation. So far as the correlograms show similarities, it would seem that they can be classified into two types. The correlograms for atomic volumes, densities and compressibilities show a peak for the correlation of order 18, and a trough for that of order 10 or very near it, which corresponds to the elements 19 (potassium) and 11 (sodium) respectively, and thus reveal a period of length 18, which corresponds to twice the fundamental period of the chemical periodicity of 8, plus the first two elements of the table. The correlograms for melting points and ionization potentials, on the other hand, show, in addition to the period of length 18 (16), a smaller one with peaks at 8 and 26, or very near them, and thus a greater similarity to the chemical periodicity of the elements with its fundamental period of 8.

Since the melting points (the temperature at which the atoms begin to leave the crystal lattice) and ionization potentials (the energy needed for removing an electron from the atom) have this in common, that they both refer to the point where lattice disorder sets in, and thus to the *dynamic* properties of matter, whereas atomic volumes, densities and compressibilities are properties of the *static* atom, it would seem that this difference is faithfully portrayed in the respective types of physical periodicity as revealed by the correlogram.

Investigations of this kind may afford an indication for linking more intimately than has been done so far the mechanism of the various physical periodicities with the periodic system of the electrons constituting the shells and subshells of the atom.

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X-Ray Scattering by Thermal Vibrations in Crystals

Sir C. V. Raman, in his letter on "X-Rays and the Eigen-Vibrations of Crystal Structure"[1], claims that the elastic vibrations cannot "give rise to any geometric diffraction pattern exhibiting an observable relationship to the structure of the crystal". The reasons given for this statement make it appear that he has fallen into Debye's original error, and supposes that the atomic vibrations are essentially independent, or are markedly dependent on the form of the crystal and on external boundary conditions. This would perhaps be the case for very small crystallites; for crystals of ordinary size the boundary conditions would involve second-order effects only, as they do in the case of Bragg reflexion. It should also be clearly understood that the change of frequency due to the X-ray 'Doppler effect' is so small that the modified wave-lengths still lie well within the width of the monochromatized $K\alpha_1$ line, assuming that to be the incident radiation; the change is of the order of 1 in 10^5.

That the elastic vibrations do indeed give rise to a geometric diffraction pattern has been most conclusively proved by the excellent agreement between theory and experiment for metals such as sodium, lead and tungsten. The theory of eigen-vibrations can offer no explanation whatever of these experimental results, whereas the elastic vibration theory predicts them correctly in every detail[2].

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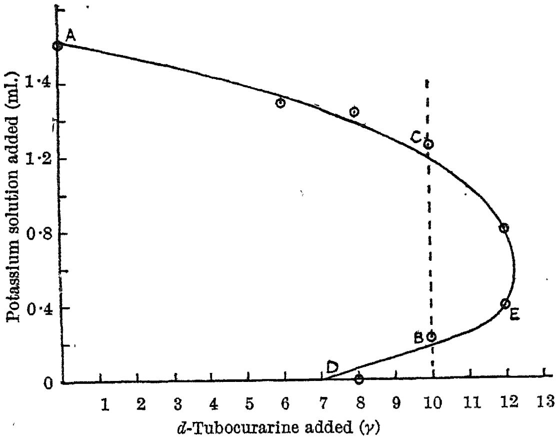
Interaction between Curare and the Potassium Ion at the Motor End Plate

In a previous paper[1] evidence was presented that there is a relation between the curariform activity of an onium ion and the charge density on its quaternary central atom. A consideration of this theory and of the fact that the paralysing action of curare can be reversed by a fall of temperature[2] led to an investigation of the antagonism between curare and the potassium ion[3].

By working below 30° C., it has been possible to study the actions on the rat diaphragm[4] of potassium ion concentrations which reduced neuromuscular transmission while leaving the muscle fibres fully responsive to direct electrical stimulation. Under these conditions, it was possible to demonstrate a neuromuscular block by high concentrations of the potassium ion alone (point *A* on graph). This block may be similar to that produced in ganglia by high doses of potassium chloride[5]. The graph also shows that by bringing the muscle into equilibrium with increasing concentrations of curare it has been possible to demonstrate that the addition of curare reduces the concentration of potassium required to cause a 50 per cent block. When the dose of curare which causes a 50 per cent block at normal concentrations of potassium ions is exceeded, the addition of potassium ion has two opposite actions (dotted line). First it antagonizes and decreases the block, the point *B* giving the potassium ion concentration which produces a 50 per cent block, and then after reducing the block still further a point is reached when more potassium sums with the curare and causes the block to increase again. The point *C* represents the 50 per cent block produced by adding excess potassium ions. The line *D*—*E* corresponds to the potassium ion – curare antagonism observed earlier[3].



Relationship between *d*-tubocurarine chloride added to a 40 ml. bath and the amount of Tyrode solution containing 100 times the normal amount of potassium chloride required to maintain the neuro-muscular conduction of the preparation in a state of 50 per cent block

It appears to us that the interaction between curare and the potassium ion is an ion exchange reaction (cf. ref. 6 in this connexion), and that the region of the motor end-plate contains an ion exchanger. Moreover, we would like to suggest that in normal neuromuscular transmission the onium ion group of acetylcholine liberated by the nerve impulse reacts with the exchanger, to which potassium ions are normally bound, and that the potassium ions so displaced stimulate the muscle fibre, possibly by depolarizing it. The liberation of acetylcholine ions and their displacement of potassium ions from the ion exchanger would give rise to potentials of the liquid junction type. Moreover, the depolarization of the muscle fibre by the potassium ions would set up electrotonic and action potentials. The complexity of end-plate potentials[7,8] is therefore not unexpected. The marked similarity between the actions of potassium and acetylcholine[9] becomes easy to understand; and the continued occupation of the receptors of the ion exchanger by curare, stable choline esters and acetylcholine after eserine[10], by preventing the reoccupation of those receptors by potassium ions in preparation for the next impulse, explains the blocking action of these substances. We can represent the reaction between the receptors of the exchanger and the potassium ion briefly as follows:

$$R^- + \mathrm{K}^+ \rightleftharpoons R\mathrm{K}.$$

Normally, the acetylcholine liberated by a nerve impulse, by combining with free receptors and blocking the left to right part of the equilibrium, would leave the dissociation of potassium ions unopposed, with a consequent local rise in potassium concentration at the muscle fibre. If we decrease the free receptors by raising the potassium ion concentration, then acetylcholine cannot combine; hence the blocking action of excess potassium and its summation with curare when the number of free receptors is the limiting factor. Curare acting on normal muscle would decrease that potassium bound to the receptor which is available for exchange with acetylcholine. In this case, potassium ions would antagonize curare by increasing the available bound potassium.

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Effect of Drugs on Actin

In previous work from this laboratory it has been established that the polymerization of actin is influenced by various ions in different ways. In view of the possibility that the change of globular actin into fibrous actin plays an important part in the mechanism of muscle contraction, it is especially interesting that calcium and potassium (or sodium) ions show antagonistic action at some concentrations[1].

When globular actin polymerizes, the reaction-rate can be followed by the rising viscosity of the solution. The reaction is usually of an autocatalytic type; therefore the rate is best measured by the reciprocal value of the time needed to reach 50 per cent polymerization. Such a study, using 0·001 *M* calcium chloride and varying concentration of potassium

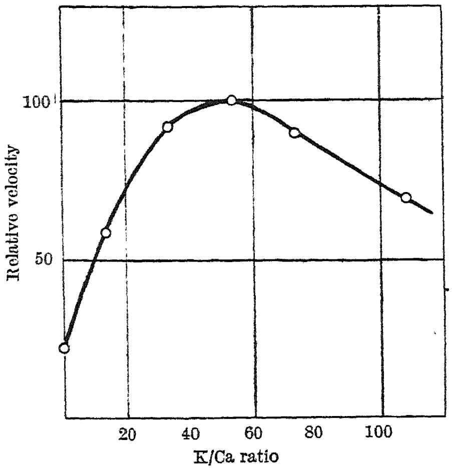

Fig. 1. Variation in the rate of polymerization of actin in presence of calcium (0·0005–0·001 M) and potassium (0–0·11 M) ions

chloride (pH 7) at 24° C., gave the results represented in Fig. 1. As the rate of polymerization of a given actin preparation is variable, the results are represented as a percentage of the rate obtained at the physiological potassium – calcium ratio. It is seen that in this type of experiment a synergistic action of calcium and potassium is observed, with an optimum at the physiological ratio.

The effect of many of the drugs which act directly on muscle is analogous, and is supposed to be related, to the action of one or other of the cations of the tissue. It was therefore of interest to study the effect of such drugs on the ion-catalysed reaction of the polymerization of actin. We have found that the rate of polymerization was greatly enhanced by adrenaline (0·1 mgm./ml.), whereas it was inhibited in presence of the same concentration of quinine, strychnine and veratrine. The study of these effects at varying potassium – calcium ratios gave the very suggestive curves of Figs. 2 and 3. In both these figures the ordinate represents percentage change in the rate of polymerization when compared with a control experiment in which actin was polymerized in presence of the same ions but without the addition of the drug.

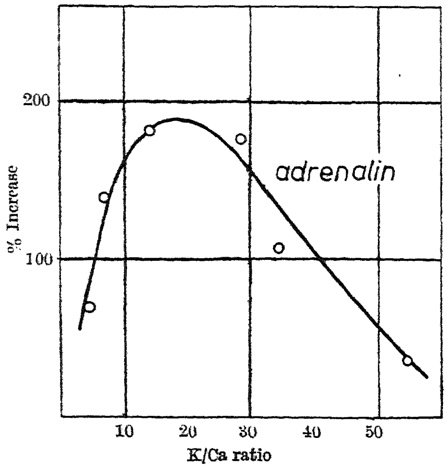

Fig. 2. Change in the rate of polymerization of actin in presence of adrenaline (0·1 mgm. per ml.) in relation to the rate of polymerization in presence of the same salt concentration but in absence of drug

A purified concentrate of the prosthetic group of actin (0·1 mgm./ml.) gave rise to effects similar to that of adrenaline.

Different preparations of actin are influenced by the above-mentioned drugs to a varying degree even at constant ionic environment. This lends further support to the conception advanced in an earlier paper[1] that the process of polymerization is a series of reactions, any one of which might be the limiting factor in a given preparation. One of these reactions can be catalysed either by the prosthetic group of actin or by calcium and adrenaline.

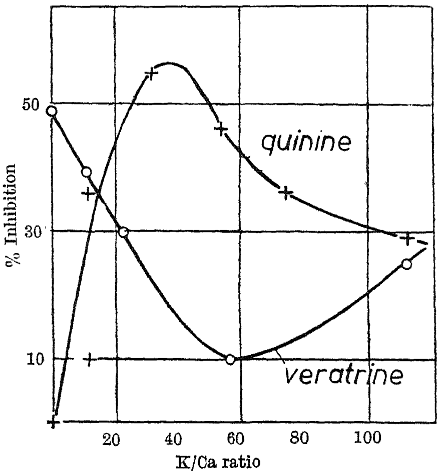

Fig. 3. Effect of quinine and veratrine (0·1 mgm. per ml.) on the polymerization of actin under the same conditions as for Fig. 2

The present results make it very probable that the molecular changes of actin are involved in the contraction mechanism.

A detailed account of this work will appear in the *Hungarica Acta Physiologica*.

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Actomyosin Content of the Uterus

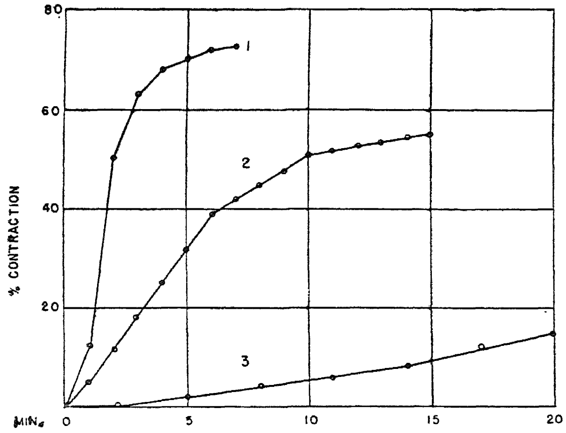
THE methods developed by the Szent-Györgyi school[1] offer a possibility of characterizing and explaining the well-known differences which exist between the pregnant and the non-pregnant uterus. I have applied these methods to the study of human and animal uteri under normal conditions, in different stages of pregnancy and in certain pathological cases.

The actomyosin of the frozen uterus was extracted with 3 volumes 0·5 mol. potassium chloride, in the presence of 2·5 mgm./gm. muscle adenosine triphosphate, by thoroughly grinding it with sand. The viscosity of the actomyosin solutions with and without the addition of adenosine triphosphate, and the contraction of the actomyosin thread in the presence of adenosine triphosphate, were measured. Both methods show that the extracted material is a mixture of actomyosin and myosin. The data in the accompanying table were obtained from viscosity determinations calculated according to Szent-Györgyi and Straub[2,3].

Material	Amounts of actomyosin and myosin in the solution extracted from 1 gm. material		
	Mixture	Myosin	Actomyosin
Non-pregnant human uterus	16	11	5
Human uterus during labour (Cæsarean sect.)	22	9	13
Human cross-striated muscle	44	18	26

The absolute and relative actomyosin content of the non-pregnant uterus extracts is much lower than that of cross-striated muscle, and increases with advancing pregnancy, rapidly reaching its maximum immediately before parturition.

The contraction of a thread of actomyosin, followed in time, clearly demonstrates the differences between the pregnant and the non-pregnant uterus (see graph).



Contraction of actomyosin threads prepared from human uteri: (1) during labour; (2) from non-pregnant uteri; (3) from uteri after X-ray castration

These observations seem to explain many problems in the physiology and even pathology of gravidity and parturition (abortion at too high, and very weak labour at too low, concentrations of actomyosin ?).

More work is planned along this line, and a detailed report will appear elsewhere.

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Production of Riboflavin and Allied Substances during the Growth of *C. diphtheriæ*

While studying, by paper partition chromatography[1], the utilization of amino-acids during the growth of the Park Williams No. 8 strain of *C. diphtheriæ*, we noted a strong yellow fluorescence with ultra-violet light of culture filtrates of the organism grown on a casein hydrolysate medium prepared essentially according to the method of Mueller and Miller[2]. When such culture filtrates were run on chromatograms using *n*-butanol-acetic acid as the solvent[3], two strongly fluorescent yellow spots were observed when the dried paper was placed under an ultra-violet lamp. Neither of these spots gave any colour when the paper was sprayed with 0·1 per cent (w./v.) ninhydrin in chloroform. One of them was in a position approximating to that occupied by proline and the other to that occupied by the basic amino-acids.

It was suggested to us by Dr. W. A. Rawlinson that these fluorescing spots might be due to flavins, and we have since learned that Wadsworth and Crowe[4] have shown that a special strain of *C. diphtheriæ*, grown on a synthetic medium, elaborated an unidentified flavin. We found that the faster moving spot had the same R_f value as riboflavin when run with either *n*-butanol-acetic acid or collidine as solvent. Moreover, when these spots were eluted from the chromatogram, both showed riboflavin activity, as did the original culture filtrate, when examined by the usual microbiological technique using *Lactobacillus casei* E. as the test organism. The crude culture filtrate had an activity equivalent to 25 μgm. of riboflavin per ml.

We found, also, that the fluorescent material behaved chemically like riboflavin. It was resistant to the action of potassium permanganate and hydrogen peroxide, would pass through a 'Cellophane' bag, and could be adsorbed on Fuller's earth and 'Super-filtrol', from which it could be eluted with small volumes of 20 per cent (v./v.) pyridine in 2 per cent (v./v.) acetic acid solution. Such an eluate when chromatographed gave two fluorescent spots, in the same position but much more intense than those on the chromatogram of the original culture filtrate. The eluate, when evaporated to dryness and taken up in water, once again showed riboflavin activity when tested by microbiological assay methods.

Therefore there is strong presumptive evidence that the faster moving of the two fluorescent spots obtained on chromatograms of culture filtrates of the Park Williams No. 8 strain of the diphtheria bacillus is riboflavin itself, while the other may possibly be either riboflavin phosphate or flavine adenine dinucleotide, both of which have been reported by Crammer[5] as having R_f values approximating to that obtained by us for this slower moving spot.

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Sex and Organ Specificity in the Response of β-Glucuronidase to Extrinsic Agents

It was considered that the correlation shown to exist between the β-glucuronidase activity of a tissue and the amount of cell proliferation in progress[1] could explain the rise in uterine glucuronidase found by Fishman and Fishman[2] to follow œstrogen administration to ovariectomized mice. In a preliminary kinetic study of the enzyme in mouse uterus, the *p*H-activity curve for the hydrolysis of phenol β-*d*-glucuronide was found to be almost symmetrical about *p*H 4·5. This is in contrast to the curves

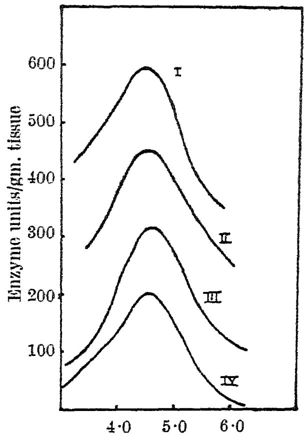

Fig. 1. *p*H-Activity curves for uterine glucuronidase
I, 10-day old mice; II, ovariectomized adults, 3 days after subcutaneous injection of 50 μgm. œstrone; III, normal adult; IV, ovariectomized adults

previously found for liver and spleen glucuronidase in the normal mouse[3], with peaks at *p*H 5·2 as well as at 4·5. Mills[4] has shown that beef spleen glucuronidase can be separated into two fractions, *A* and *B*, with slightly different *p*H optima for the hydrolysis of menthol glucuronide. Since it seemed probable that mouse uterus lacked a glucuronidase fraction present in liver and spleen, it was considered necessary to investigate the possibility that differences between *A* and *B* in distribution and response to extrinsic agents might in some way explain the selective actions of such substances as carbon tetrachloride and œstrone on liver and uterine tissue respectively.

As can be seen from Figs. 1 and 2, the *p*H activity curves for liver and uterine glucuronidase were unchanged in shape during active growth. The high figure for uterine glucuronidase in infant mice supports the view that in this organ, as in others, the activity of the enzyme is a measure of cell division. The effect of carbon tetrachloride on liver does not suggest any selection between the glucuronidase fractions. Carbon tetrachloride is known to have no effect on kidney glucuronidase[5], in spite of the fact that the *p*H activity curve has been found to have the same general shape as that shown for liver.

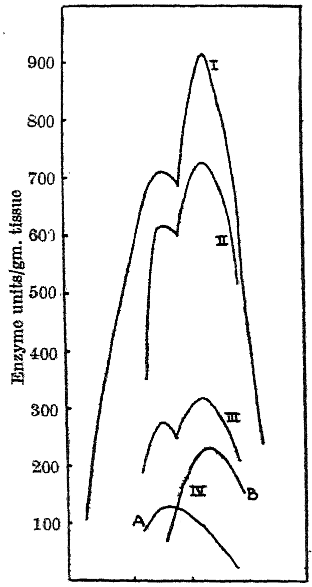

Fig. 2. *p*H-Activity curves for liver glucuronidase.
I, 6-day old mice; II, adult, 1 day after subcutaneous injection of 5 gm. chloroform/kgm.; III, normal adult; IV, the same preparation as III after separation of *A* and *B*

In further experiments, fraction *A* was precipitated by making the preparation 38·5 per cent saturated with ammonium sulphate[4] at *p*H 5·2, and the two fractions were then determined separately. All uterine enzyme was found in fraction *A*. The separation achieved is illustrated for a liver preparation in Fig. 2. In the response of liver glucuronidase to chloroform, and kidney to mercuric nitrate, *A* and *B* were equally affected. Eschenbrenner and Miller[6] found the production of renal necrosis in mice by chloroform, seen only in males, to be prevented by castration, and noted a correlation between kidney morphology and its susceptibility to chloroform. Morphological differences were confined mainly to Bowman's capsule; but this was not involved in the necrosis. The response of kidney glucuronidase to chloroform observed in the male mouse[5] was abolished by castration. While figures for untreated females, males and castrated males did not suggest any differences in *A* or *B* corresponding to the variations in the structure of the kidney, the rise in kidney glucuronidase after injection of normal males with chloroform was confined to fraction *B*. This could be explained on the assumption that the two glucuronidase fractions are unevenly distributed throughout the kidney. From the other results quoted above, it appears that the response by glucuronidase to any agent is independent of the 'fraction' present in the cell affected. For the comparative study of the effects of extrinsic agents on organs such as liver and kidney, it would appear adequate to determine the total enzyme activity at *p*H 5·2. The importance of determining the *p*H-activity curve for each new organ examined is, however, emphasized by the findings for the uterus.

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April 8.

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Aneurin-Pyrophosphate Content of Red and White Blood Corpuscles in the Rat and in Man

WE have determined accurately the aneurin-pyrophosphate content of red and white blood corpuscles in the rat and in man. Rats in a well-nourished condition and with slight aneurin deficiency were examined, and also human subjects, both healthy and suffering from various diseases. Determinations were carried out in two blood fractions, obtained by centrifuging, one containing a large number of red cells and very few white cells, the second containing practically all the leucocytes of the blood sample and relatively few erythrocytes. Centrifuging must be carried out at a low rate, as at high rates the white cells agglutinate and cannot be resuspended for counting. Cell counting[1] must be performed with great care, as it is subject to much larger errors than the aneurin-pyrophosphate determination. The latter was carried out according to Westenbrink *et al.*[2].

Working with seven well-nourished male albino rats, their red cells contained 2·1 ± 0·41 γ aneurin-pyrophosphate per 10^{11} cells, the white cells 340 ± 100 γ per 10^{11} cells; so the average rat leucocyte contains about 160 times as much as an erythrocyte.

For eight normal men the average red cell content was 1·49 ± 0·08 γ aneurin-pyrophosphate per 10^{11} cells; for fourteen normal women the average was 1·28 ± 0·09 γ per 10^{11} cells. This sex difference was significant. Such a difference was not found for the white cells, their average content being 280 ± 45 γ per 10^{11} cells. So for human beings the ratio of the contents of a red and a white cell is about 1 : 200.

Although the aneurin-pyrophosphate content of erythrocytes is low, they contribute most to the aneurin-pyrophosphate of total blood, owing to their very large number.

A ration containing less than 0·15 γ aneurin a day (a rat needs about 10 γ a day) caused a significant decrease of the aneurin-pyrophosphate content of rat erythrocytes from 2·1 ± 0·41 γ to 1·0 ± 0·19 γ per 10^{11} cells in five days; the decrease of the leucocyte content was much less pronounced and only just significant, namely, from 340 ± 100 γ to 240 ± 58 γ per 10^{11} cells. The decrease of the red cell content in the avitaminotic rats runs roughly parallel to the decrease in liver, kidney and muscle, while the decrease of the white cell content is roughly proportional to that of the brain. This shows that differential determination of the aneurin-pyrophosphate content of the blood corpuscles provides conclusive information regarding the aneurin-level of the body.

When seven human subjects (six men and one woman) received an aneurin-poor diet for ten days, the average aneurin-pyrophosphate content of the red cells had decreased to about 1·15 ± 0·08 γ per 10^{11} cells, while the decrease of the white cell content, though distinct, was less pronounced. Human blood cells thus appear to be slower in losing their aneurin-pyrophosphate than rat cells.

In two cases where abnormally high values for the red cell content were found in apparently healthy subjects, this appeared to be due to the abnormally large volume of their erythrocytes, the aneurin-pyrophosphate content being normal when reduced to normal cell volume.

The aneurin pyrophosphate content of the red cells also appeared to depend upon their age; in the nucleated stage they may contain as much as 100–160 γ per 10^{11} cells.

In general, our work on pathological subjects, comprising cases of pernicious anæmia, primary liver carcinoma with extensive hæmorrhagia, erythroblastosis, lymphatic leucæmia, pyloris stenosis, myeloid leucæmia, and of aneurin deficiency, has shown that conclusions regarding the aneurin-level of the body cannot be based upon aneurin-pyrophosphate determination in total blood only. A blood count must always be made and the blood picture studied; for a reduced number of red cells can depress heavily the total content of blood even while the content of each cell may be normal or even increased. Conversely, in a case of leucæmia with a total blood content of 210 γ per 100 cm.^3 (normal: ± 8 γ per 100 cm.^3), this very high value was caused by the extremely large number of white cells.

A full account of our experiments and discussion of the accuracy of the results will appear in *Biochimica et Biophysica Acta.*

This work forms part of investigations on aneurin metabolism being carried out by Prof. H. G. K. Westenbrink and collaborators.

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A Hyaluronidase Unit

DESPITE our deficient knowledge of the physical and chemical properties of both hyaluronic acid and hyaluronidase, it seems desirable to have a hyaluronidase unit, which can be used until international standard preparations are available for comparison, in order to be able to correlate the numerous investigations being carried out with this substance. All investigations so far suggest that the viscosimetric method of estimation at present affords the best possibilities for quantitative analysis of a biological material.

By a series of investigations into the individual phases of the viscosimetric estimation, we have obtained a unit for hyaluronidase. We define this unit as the amount of enzyme which at 37° C. in the course of 300 sec., by its action on 1 litre of a solution of roughly purified hyaluronic acid from synovia of recently killed cattle with a time of flow in a special viscosimeter of about 2·5 times that for water, reduces the increase in time of flow due to hyaluronic acid to half that period. We find it more important at present that the conception of a unit should be attached to an easily accessible hyaluronic acid preparation and a viscosimeter of fixed dimensions than to provisional local standard preparations of the enzyme.

The hyaluronic acid preparation applied is prepared from synovial fluid produced by puncture of the hock of cattle immediately after killing. The synovial fluid is diluted with an equal part of distilled water, after which the hyaluronic acid is precipitated by addition by drops of glacial acetic acid. The resulting coagulum is washed with distilled water and dissolved in phosphate citric acid buffer $M/60$, pH 7·0 (after McIlvaine) with 3·5 per mille sodium chloride. The solution is adjusted to a relative viscosity of about 3 and pH 6 by addition of buffer and 4 N sodium hydroxide.

The viscosimeter used is U-shaped with a wide tube of internal diameter 6 mm. and a capillary tube of internal diameter 0·3–0·4 mm., forming the bend and the measurement section. On this latter is a broadened region with a volume of 0·2 ml., delimited above and below by scratch marks. The distance from the lower mark to the bend is 175 mm.

A further account of the procedure of analysis pertaining to a viscosimetric rapid method will be published in the *Acta pharmacol. et toxicol.* (Copenhagen).

Since devising this method, we have been able to examine a sample of hyaluronidase from the Treemond Company, Brooklyn, N.Y. This sample was declared to contain 100 turbidity-reducing units per mgm.; by our method this was found to be equal to 2 hyaluronidase units as defined above. We therefore expect the ratio of the turbidity-reducing unit to our hyaluronidase unit to be approximately 50.

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Indicator Yellow and Retinene$_1$

IN their interesting article on the "Chemistry of Visual Processes", Ball, Collins, Morton and Stubbs[1] consider that Lythgoe's indicator yellow[2] is a "fortuitous artefact having no direct relevance to visual chemistry". They base this conclusion on the fact that retinene$_1$ may be extracted from bleached retinæ or from bleached visual purple (rhodopsin) solutions by a mixture of acetone, ethanol and light petroleum ether and that "free or loosely bound retinene$_1$ (the final product of bleaching rhodopsin) may combine with any suitable protein or amino-acid which may be available". They regard this fortuitous combination as the means of production of indicator yellow in solution.

These facts do not, however, justify their conclusion. Lythgoe[2] was unable to extract retinene from bleached visual purple solutions using petroleum ether alone as solvent. Hecht[3] has pointed out that alcohol must be added to the petroleum ether in order to extract the retinene. Again, if cold acetone is added to a bleached visual purple solution, the precipitate "contains not only the protein but most of the yellow colour. The retinene must therefore still be mainly attached to the protein, since carotenoids are not easily adsorbed in the presence of high concentrations of acetone" (Hecht, *ibid.*).

The inference is plainly that, after bleaching, the altered visual purple chromophores are still attached to the parent protein (this arrangement constituting the indicator yellow molecule), unless an active reagent such as alcohol strips these altered chromophores (retinene) from the protein. Thus by using alcohol, or other active agent, in the solvent, one is extracting a substance retinene, which is *not*, in fact, "the final product of bleaching rhodopsin". The recombination of retinene with a suitable protein (perhaps, indeed, the original protein from which it was detached) to yield 'indicator yellow' could then scarcely be described as 'fortuitous' but rather the restitution of the original state of affairs.

The visual purple molecule consists of a protein 'base' to which are attached about ten chromophores[4]. It is known that when one quantum of light is absorbed one chromophore is altered[5], but there is no evidence for the statement, often occurring in the literature, that the secondary process following activation of the chromophore is a loosening, that is, a dissociation of the chromophore-protein bond. It is just as probable that activation of a visual purple chromophore by a light quantum is succeeded by a chemical process resulting in an electron transfer down the conjugated carotenoid chain to the protein base and thence, *in vivo*, to the retinal end-organ to which, in all probability, the visual purple molecules are attached. This gives us a simpler picture of the genesis of the physiological impulse than does the usual view that the retinal end-organs are stimulated by a product of the disrupted visual purple molecule.

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THE facts quoted by Dr. Dartnall do not invalidate our conclusions. If under the action of light the retinene is split off, the conditions are such that it is available for recombination with any protein to form new compounds. The spectroscopic evidence indicates that there are three materials in bleached rhodopsin solutions, retinene (or retinene + protein) and the acid and alkaline forms of indicator yellow. We consider that, although the same protein is concerned in all three compounds, yet the chemical evidence indicates that in indicator yellow, retinene is firmly bound while in neutral bleached rhodopsin solutions it is only weakly bound. We agree with Dr. Dartnall's final paragraph.

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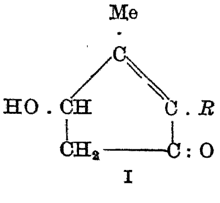
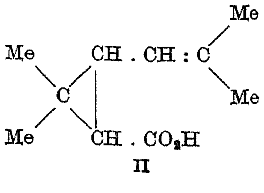
Total Synthesis of some Pyrethrins

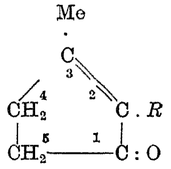
IN view of recent publications in the United States, it is desirable to record briefly some of the results obtained by us during the past year or so. Following the demonstration by LaForge and Barthel[1] of the heterogeneity of 'pyrethrolone', the alcoholic component of the pyrethrins, and the revision by LaForge and Soloway[2] of the structures of the constituent alcohols to (I), where *R* is butenyl or pentadienyl, and the synthesis by Campbell and Harper[3] of (−)-*trans*-chrysanthemum monocarboxylic acid (II), the enantiomorph of the acidic component of pyrethrin I, the total synthesis of various pyrethrins (that is, esters of I with II), the insecticidal constituents of pyrethrum flowers, appeared a more favourable project than previously.



I



II



III

A convenient route to ketones of type (III) was explored by Harper[4], by the preparation of ketones, in which R = n-butyl and butenyl, the former being identical with dihydrocinerone and the latter isomers of cinerone; and has since been extended to higher analogues, in which R = n-amyl, pentenyl, etc. If direct substitution could be effected in position 4, then subsequent condensation with chrysanthemum monocarboxylic acid would provide a convenient route to pyrethrins, in which structural and stereochemical variations could be readily made. The 4-position is analogous both to the γ-position of crotonaldehyde and crotonic esters and to the β-position of saturated esters, and might therefore be expected to undergo free radical substitution more readily than elsewhere. Developing this approach, we have been able to effect smooth substitution of bromine, using N-bromosuccinimide in carbon tetrachloride, to give what we believe to be the 4-bromoketone, though we have not yet established this unequivocally. Nevertheless, reaction with silver acetate in glacial acetic acid gives the corresponding acetoxyketone, which is saponified to the hydroxyketone, of the same series, irrespective of the absolute structure, as natural pyrethrolone and cinerolone. When R is n-butyl, the product is (±)-dihydrocinerolone, which has also been synthesized by a similar method by Soloway and LaForge[5]; and when R is n-amyl, the product is (±)-tetrahydropyrethrolone, which has also been synthesized by a similar method by Dauben and Wenkert[6] (see Table 1).

Table 1

	(I), R = n-Butyl	Dihydrocinerolone	Ref.
Alcohol	b.p. 114–117°/0·8 mm.	(+) 115–117°/1 mm.	1
	n_D 1·4946 (19°)	(+) 1·4958 (22°)	1
Semicarbazone	m.p. 184–185°	(±) 185°, 184–185°	1, 8
3:5-Dinitrobenzoate	m.p. 110–110·5°	(±) 111°	5
Acetate	b.p. 100–103°/0·75 mm. 97°/0·25 mm.		
	n_D 1·4788 (20°) 1·4772 (20°)		
Acetate 2:4-dinitrophenylhydrazone	m.p. 125–126°		
	(I), R = n-Amyl	Tetrahydropyrethrolone	
Alcohol	b.p. 127°/0·4 mm.	(+) 124°/0·6 mm.	
	n_D 1·4882 (25°)	(±) 1·4892 (28°)	
Semicarbazone	m.p. 169°	(±) 172–173°, 172–174°	1, 8
3:5-Dinitrobenzoate	m.p. 105–106°		
Acetate	b.p. 103°/0·4 mm.	(+) 117°/1·3 mm.	9
	n_D 1·4747 (25°)	(+) 1·4761 (20°)	9

Having established the relationship of these products to the pyrethrins, we have now submitted the bromoketone in carbon tetrachloride to reaction with the silver salt of synthetic chrysanthemum monocarboxylic acid and isolated by distillation the corresponding pyrethrin. Table 2 lists the synthetic esters we have obtained, and their stereochemistry. These esters have been tested for insecticidal properties, and are of a low order, thereby confirming the low toxicity reported by LaForge and Barthel[7] for tetrahydropyrethrin I.

Table 2

(I), R=	Stereochemistry of alcohol	Stereochemistry of acid	B.p.	n_D^{20}
n-Butyl	(±)	(±)-*trans*	115–116°/1 × 10^{-3} mm.	1·4992
n-Butyl	(±)	(±)-*cis*	117–119°/3 × 10^{-4} mm.	1·5000
n-Amyl	(±)	(±)-*trans*	96°/7·8 × 10^{-4} mm.	1·4970
n-Amyl	(±)	(±)-*cis*	120–124°/2·1 × 10^{-3} mm.	1·4980

Experiments are in progress to establish beyond doubt the position of substitution and to investigate the extension of this method to ketones in which R = butenyl, pentenyl, etc.

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Alkaloids of the Australian Rutaceæ

In certain tribes of the family Rutaceæ a relatively high proportion of species has been found to contain alkaloids. Moreover, these alkaloids vary widely in character and include representatives of several of the principal structural groups, for example, quinoline, *iso*-quinoline, carboline and imidazole derivatives.

We are examining the alkaloids of a number of Rutaceous genera of the Australian flora, particularly those of the Queensland tropical rain-forest. This work is part of a general survey of the occurrence and pharmacology of alkaloids in the Australian flora, which is being undertaken by the Council for Scientific and Industrial Research in collaboration with the departments of chemistry and physiology of several Australian universities. At least six unrecorded alkaloids have been isolated from the three rain-forest species, *Melicope fareana* F. Muell., *Evodia xanthoxyloides* F. Muell., and *Acronychia baueri* Schott. Of these, five are certainly related and exhibit a number of novel features. The bark of *Melicope fareana* contains melicopine ($C_{17}H_{15}O_5N$, pale yellow needles, m.p. 178·5–179·5°), melicopidine ($C_{17}H_{15}O_5N$, pale yellow prisms, m.p. 121–122°), melicopicine (yellow prisms, m.p. 131–132°), and acronycidine ($C_{15}H_{15}O_5N$, colourless needles, m.p. 136·5–137·5°). The leaves of this tree also contain melicopine, melicopidine and melicopicine, but acronycidine is absent. There is present, however, a small amount of another colourless alkaloid which has not yet been obtained in a pure form. The bark of *Acronychia baueri* contains acronycine ($C_{20}H_{19}O_3N$, pale yellow needles, m.p. 174–175°), melicopine, melicopidine and acronycidine, while melicopicine has been isolated from the leaves. The bark of *Evodia xanthoxyloides* contains evoxanthine ($C_{16}H_{13}O_4N$, pale yellow needles, m.p. 217–218°), and melicopidine.

Although the structural problems have not yet been completely clarified, it has been established that the five yellow alkaloids are acridine derivatives, actually N-methyl acridones. Acronycidine (colourless) is probably a quinoline derivative related to skimmianine. A number of other species belonging to the same and related genera are under examination, and it is hoped to correlate the nature of the alkaloids with the taxonomy of the groups concerned. Full details of this work will be published elsewhere.

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Determination of Mixing of Gas Streams by the Infra-Red Gas Analyser

A technique developed by this laboratory for use in model experiments on the mixing of air and gas in the open hearth furnace has application to any problem of turbulent diffusion between streams of similar gases, in which mean concentrations of one gas in the other are to be sampled. The method used combines high sensitivity and rapidity of response with freedom from poisonous tracer substances.

The technique is at present being applied to the study of mixing in a model of a producer gas-fired open hearth furnace. Both air and fuel gas are replaced in the model by air at room temperature, and the pattern of mixing between the air from the gas port and that from the air ports is studied. This pattern is of great importance in furnace design as it determines shape of the flame and rate of burning. To obtain Reynold's similarity with a 1/12-scale model a flow rate of nearly 7 cubic metres/minute is needed, which necessitates a highly sensitive detector if the flow-rate of the tracer is to be kept low.

Originally, consideration was given to the use of a radioactive tracer such as radon, which has already been used both for full-scale furnace experiments and in the laboratory[1,2]; but the commercial production[3] of the infra-red gas analyser provides a means of obtaining sensitivity without the inconvenience of a tracer which decays with time. Using carbon dioxide, a full-scale deflexion is obtained with a concentration of 0·03 per cent, corresponding to a flow of 2 litres/minute, of pure carbon dioxide. In a well-ventilated laboratory, this may be safely run to waste. At the rate of aspiration used, the speed of response of the instrument, including delays introduced in the tubing, is better than 5 sec. for two-thirds final reading.

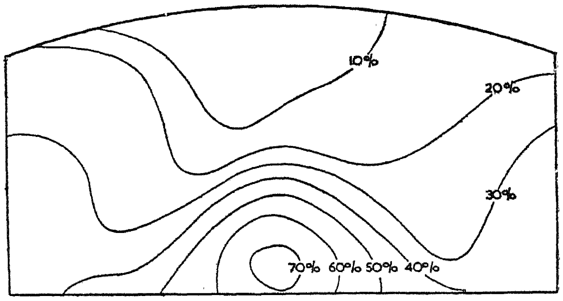
Precautions are necessary to eliminate the effect of changes in the concentration of carbon dioxide in the atmosphere. It has been suggested that the use of methane as a tracer would avoid this. The infra-red gas analyser can be made almost as sensitive to this gas (about 0·1 per cent for full-scale deflexion), so that waste removal should not be too difficult.

In the apparatus used, air is passed into the uptakes and ports of the model at measured rates. A small quantity of carbon dioxide from a cylinder is introduced into the gas port line. Samples are taken from the furnace by a probe connected by rubber tubing to the sample tube of the infra-red gas analyser. A small pump provides suction at the outgoing ends of both sample and control tube. The latter draws air continuously from the duct supplying air to the air ports, and a two-way tap enables the sample tube to be connected at will to the gas port supply line. Each of these systems is arranged to be similar in length and speed of aspiration.

At the start of the experiment the sensitivity control of the analyser is adjusted to correspond with the calibration curve provided by the makers[4]. The rate of flow of carbon dioxide is then increased until full-scale deflexion is obtained with the sample taken from the gas port line. This is checked between each reading. The probe is placed in predetermined positions and the readings taken and plotted as contours of equal concentration.

The work, not yet complete, from which the illustrations are taken is designed to supplement that done by the Steelmaking Division of this Association, on the effect of furnace design on gas and air mixing on heat transfer to the hearth[5].

Fig. 1



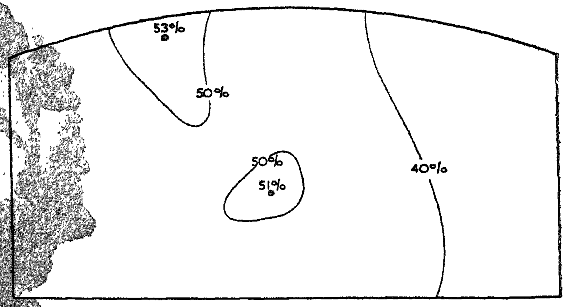


Fig. 2

The accompanying two graphs show the effect of a modification of air port design. Both represent vertical sections across basically similar furnaces at the first charging door. Fig. 1 represents the conventional design, in which points to be noted are the slow mixing shown by the high concentration of unburnt gas, the position of the flame close to the hearth, and the flow of air down the centre of the roof. Fig. 2 shows a rejected modification. Mixing is very good; but the higher concentration near the roof, especially when compared with similar sections near the end wall, indicate that the flame has been blown up to the roof, and this in practice would soon cause the roof to melt. It is to be noted that the asymmetry with respect to the centre line is in agreement with the work of Mr. A. R. Philip[6] in visualizing the flow pattern in open hearth furnaces.

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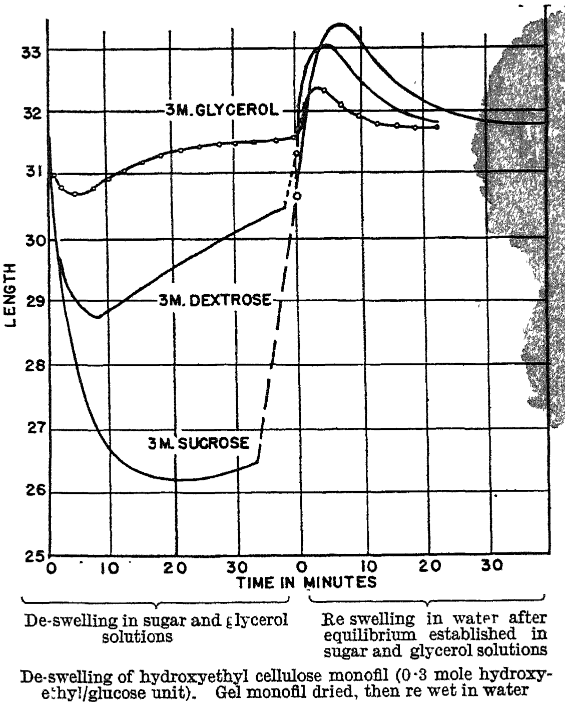
Ionic Exchange and Fibre Contraction

IN a communication under the above title, published in *Nature* of May 31, 1947, p. 746, J. L. Mongar and A. Wassermann report some experiments on the de-swelling of calcium alginate fibres in salt solutions. They noted that water-swollen alginate fibres when placed in various alkali-salt solutions first contract and then increase in length. The authors suggest that the contraction results from destruction of calcium ion cross-links between alginate chains as the calcium is replaced by alkali ions. They propose also that plastic flow is mainly responsible for the final swelling effect.

In the course of studies carried out some time ago, we found that water-swollen cellulosic fibres when placed in aqueous salt solutions also contract rapidly at first and then re-swell. The same phenomenon occurs in sugar or glycerol solutions. Some typical observations on water-swollen hydroxyethyl cellulose monofils (0·3 mole hydroxyethyl/glucose unit) are shown in the accompanying graph.

We believe that the contraction is caused by water migrating out of the filament to establish osmotic equilibrium. Eventually, as the solute diffuses into the filament, the osmotic forces are reversed and water flows into the filament, causing an increase in length. It appears to us that the same processes are probably responsible for the shrinking–swelling phenomenon of calcium alginate fibres in salt solutions. If this is true, then considerations of cross-linking and plastic flow are unnecessary.



De-swelling of hydroxyethyl cellulose monofil (0·3 mole hydroxyethyl/glucose unit). Gel monofil dried, then re wet in water

Flory[1], Hermans[2], and others have developed theories which consider swelling as being an osmotic phenomenon. According to these theories, which appear to be applicable in the present case, swelling is related to the entropy of chain configuration, and equilibrium is established when osmotic entropy and entropy of chain configuration are equal (neglecting heat of mixing). If osmotic entropy is changed by adding a solute to the swelling liquid, the swollen structure will shrink. If a solute diffuses into the swollen structure, osmotic entropy changes and swelling will increase. This can be demonstrated quite simply by allowing a cellulose monofil to come to equilibrium with a sugar solution and then placing it in water, as indicated in the graph. Water migrates in to establish equilibrium with sugar molecules in the swollen cellulose structure, increasing its swelling beyond the water-swollen state. As the sugar molecules diffuse out of the gel, it gradually returns to its original water-swollen dimensions.

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April 19.

[1] Flory and Rehner, *J. Chem. Phys.*, **11**, 521 (1943); Flory, *Chem. Rev.*, **35**, 51 (1944).

[2] Hermans, J. J., *Trans. Farad. Soc.*, **42**, 91, pt. 8–9 (Aug.–Sept. 1947).

The Potato Caterpillar Pest (*Agrotis* spec.) of Tristan da Cunha

THE reports of the Norwegian Scientific Expedition to Tristan da Cunha (1937–38) and of the naval authorities who were stationed on the island during the Second World War have directed attention to the fact that the potato crop, on which the islanders depend so much for food, was seriously affected by the ravage of a caterpillar. Before the departure of the recent expedition sent to the islands by a group of South African fishing interests, it was impossible to find out more about this pest.

As members of this expedition, which left Cape Town on January 29 in the M.V. *Pequena*, it was one of our tasks to study the 'potato grub' problem and to try to find a method of control. We were informed by the Rev. C. P. Lawrence and islanders that the pest had only been noticed since the old custom of using kelp (consisting chiefly of *Macrocystis pyrifera*, Ag., and a small amount of *Ecklonia* sp.) as manure for the potato patches was abandoned and sheep manure used instead. If this observation be accurate, it suggests an interesting line of research, for the kelp would seem to render the soil unsuitable for the development of the caterpillar. In the one month available such a line of research could not be followed, but time did permit the testing of the effects of insecticides on the caterpillars.

We found that only one species of insect was responsible for the damage. Dr. A. J. T. Janse of the University of Pretoria, who was kind enough to examine material of the species, has come to the conclusion that the species is not like any that he knows from Europe or South Africa and, therefore, has not been able to name the species.

Badly defoliated potato plants after having been attacked by the caterpillars. (Photograph by Dr. G. J. Broekhuysen)

The damage done by the caterpillars is very serious, and although we were told that the infestation this season was less than usual, we were none the less impressed by the heavy damage caused. Many patches had been completely defoliated and caterpillars were eating the haulms of the defoliated plants (see photograph). In South Africa this species is not often found on potatoes, nor does it attack the foliage of the various plants on which it occurs; but feeds on the stem at soil-level.

On our arrival in the beginning of February, most of the caterpillars were in the last two instars; but by the time we left a month later, fairly large numbers of very young caterpillars had appeared, indicating a new generation. They chiefly attacked the plants during the night, and on dry days most of them burrowed into the soil at the foot of the plants. On damp days, however, many remained feeding. This habit is well known to the islanders, who send the children in the early morning to pick the caterpillars off the plants and crush them. The caterpillars were not confined to the potato, but were found feeding on a variety of plants, including grasses, thistles, *Rumex* spp., and most vegetables, except pumpkins, tomatoes, strawberries, onions and parsley. Apart from the low settlement plateau with its potato patches, the caterpillars were also found at Cave Point and Sandy Point, both of which are uninhabited. None was found on the high plateau (about 2,000 ft.) or higher up on the mountain.

The effects of three insecticides were tested in cage experiments and two in the field. *Lead arsenate* gave an unsatisfactory average mortality of 35·1 per cent in three sets of cage experiments and is also too dangerous for a backward community such as that on Tristan da Cunha to apply; it was not tried in the field. *Sodium silicofluoride*, given as a bait mixed with bran (1 in 12 by weight), gave an average mortality of 78·2 per cent in five sets of cage experiments and up to 71·6 per cent mortality in three sets of field-tests. In one of the field-tests the concentration of the poison was cut down by half. *Wettable D.D.T.* (50 per cent), in a spray (1 ounce per gallon), gave an average mortality of 88·6 per cent in four cage experiments and 99·1 per cent in three field-tests. Again in the last field-test the concentration of the solution was cut down by half.

Unfortunately, the number of field-tests is rather limited; but they show nevertheless quite distinctly that the pest can be controlled by the use of either D.D.T. spray or sodium silicofluoride-bran bait, or by using them alternately. It will also be advisable to control the pest on the surrounding vegetation, perhaps by the introduction of some insectivorous bird. The local thrush (*Nesocichla eremita eremita*, Gould.), or 'starchy' as the islanders call it, was found to be very fond of the caterpillars. Unfortunately, the large number of rats have nearly exterminated this bird on Tristan. If the rat menace could be checked the thrushes might increase, and in any event their numbers could be augmented from the flocks on the neighbouring islands of Nightingale and Inaccessible.

A full account of the experiments conducted will be submitted for publication to the *Journal of the Entomological Society of Southern Africa.*

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W. Macnae

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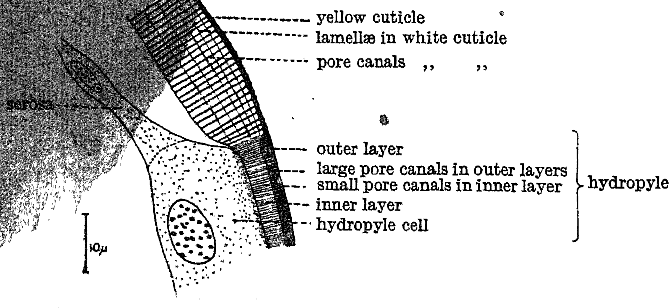
Pore Canals in the Egg Membranes of *Locustana pardalina* Walk.

It has been shown by Slifer[1] that in the egg of *Melanoplus differentialis* water is taken up through a small, circular, specialized area (the hydropyle) in the yellow cuticle. This structure, consisting of two layers, is situated at the posterior tip of the egg and is a secretory product of a group of enlarged serosal cells (hydropyle cells). According to her description, these two layers are continuous with the so-called yellow and white cuticles which cover the remainder of the egg. The outer layer of the hydropyle is several times thicker than the corresponding layer of the unspecialized yellow cuticle and is also distinctly striated. These striations (pore canals) run at right angles to the surface. Slifer also described the inner layer of the hydropyle as being continuous with the white cuticle and of the same structure.

In the egg of the South African brown locust (*Locustana pardalina*) the structure of the outer layers of the hydropyle corresponds in every detail to that of *Melanoplus*. The substance of the inner layer, however, appears to be more homogeneous than the white cuticle of the unspecialized part of



Semi-diagrammatic representation of the posterior tip of the egg of *L. pardalina* showing a small portion of the hydropyle region and adjacent unspecialized yellow and white cuticles the egg and contains a series of very small pore canals which penetrate this layer at right angles, linking up with the larger pore canals in the outer layer. These small canals are very difficult to demonstrate, but they show up distinctly in paraffin sections slightly overstained in hæmatoxylin. This suggests that they contain cytoplasmic filaments originating in the underlying hydropyle cells. The white cuticle of the remainder of the egg is distinctly laminated, and like the inner layer of the hydropyle it also contains pore canals but of a much larger size.

A detailed account of these and other features of the egg of *Locustana* will appear elsewhere.

J. J. Matthée

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Cambridge.
April 9.

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[1] Slifer, E. H., *Quart. J. Mic. Sci.*, 8, 437 (1938).

Control of Intestinal Microflora

In view of recent work which has directed attention to the importance of the intestinal microflora in nutrition, examinations of the fæces were made on a number of children receiving treatment with streptomycin.

Films showed a fair proportion of Gram-negative bacilli; but in most cases none could be grown. In other cases, streptomycin-resistant strains of *A. ærogenes* were found on culture. In no case could any *B. coli* or Gram-negative bacillus other than *A. ærogenes* be grown.

A strain of smooth *B. coli* was made streptomycin-resistant, and after attempts at inoculation by mouth had failed, rectal inoculation was successful. This has now been carried out on two cases, and in each case the organism appeared in the stools in less than 48 hours ; in one case it persisted until treatment was suspended (11 days), and in the other case it is still present at the time of writing (16 days). It is now only just resistant to 10–20 units of streptomycin per ml.

This technique may be useful in assessing the part played by various other species of micro-organisms in nutrition ; and also possibly in epidemiological problems.

My thanks are due to Prof. W. F. Gaisford for his ready co-operation, and to my laboratory steward, Mr. H. Ward, for his untiring assistance.

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April 14.

Growth of *Culex molestus* under Sterile Conditions

Aedes ægyptii and *Culex pipiens* are the only two mosquitoes which have hitherto been reared from egg to adult under sterile conditions. It is interesting to note that the autogenous *Culex molestus* can also be bred without difficulty on sterile media.

The following media were found suitable for this purpose (all experiments were carried out at a temperature of 28° C.).

(1) Dried or fresh yeast (autoclaved) 1·2 gm. to 15 ml. distilled water to which 25 eggs of *C. molestus* are added under sterile conditions. On this medium the mosquitoes developed from eggs to adult in 10·5–13 days, but the adults were not viable.

(2) Water plus dried yeast plus the following vitamins : thiamin, riboflavin, pantothenic acid, niacin, pyridoxin, folic acid (each 10 γ per ml.), biotin 0·14 γ per ml. This was the optimum medium, and the development from egg to adult lasted 7·5 days. The mosquitoes were viable. Obviously 1·2 gm. of the best samples of yeast available did not contain sufficient of the above factors to produce viable adults.

(3) Liver extract plus dried yeast (autoclaved) (Trager's medium for *A. ægyptii*). Development from egg to adult lasted 14 days and the adults were viable. Water extract of the same yeast and liver extract allowed development from egg to adult in 20 days ; but the adults which emerged were not viable.

(4) Water, glucose (0·1 per cent), a mixture of salts (0·2 per cent), casein hydrolysate (2 per cent) and the above-mentioned vitamin B complex (but with only 7·5 γ biotin per ml.) plus ascorbic acid 150 γ per ml. Although development on this medium was relatively slow (eggs to viable adults in 25 days), it proved to be the most suitable for studying the nutritional requirements of all stages of *Culex molestus*. Thus in the absence of pantothenic acid, all other factors being present, there was no development beyond the first instar ; in the absence of thiamin, riboflavin or pyridoxin, the larvæ die in the second instar ; in the absence of folic acid the larvæ reach the fourth instar but never pupate. In the absence of niacin the whole developmental cycle lasts 42 days and the adults are viable. In the absence of biotin the cycle lasts 36 days, but the adults are not viable. Ascorbic acid is not essential for complete development of viable mosquitoes, but in its absence the cycle is prolonged to 29 days.

It is interesting to note that the viable females raised on sterile media were autogenous and laid eggs in the absence of any kind of nutrition. Full details will be published elsewhere.

I have to thank Prof. S. Adler for his advice and interest in this work.

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April 1.

Mosquitoes and Malaria

With reference to the recent article on the Ronald Ross Jubilee[1], it may be of interest to note that, in a paper read at a meeting of the Royal Scottish Geographical Society in April 1892, Dr. H. Martyn Clark, of Amritsar, remarked "that, as some insects carry the pollen of one plant to the flower of another, so mosquitos [*sic*] transplant the malarial germ to a suitable *nidus* by directly inoculating their victims with it"[2]. He further stated that "it will probably some day be ascertained that the mosquito fulfils a part in their [that is, the germs of malaria] transmission". As Ross met Manson in 1894, and Manson brought forward the mosquito theory in that year, Clark's adumbration seems to be worthy of recall.

J. H. Kenneth

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[1] *Nature*, **162**, 50 (1948).

[2] Clark, H. M., "Remarks on Malaria and Acclimatisation", *Scot. Geog. Mag.*, 9, 294 (1893).

CHEMISTRY RESEARCH BOARD

A REPORT of the Chemistry Research Board which prefaces the report of the Director of the Chemical Research Laboratory for the year 1946 covers the nine-year period January 1, 1938, to December 31, 1946*, and thus presents a summary of the more important developments since the publication of the second report of the Board, which covered the three years ending December 31, 1937. A fuller account is promised in a further report which is still in preparation.

Both the Board's report and that of the Director devote considerable space to discussion of the post-war plans for the work of the Laboratory. The Chemistry Research Board proposed that the work of the Laboratory should be concentrated on a few well-selected topics in the fields of coal tar, corrosion of metals, inorganic chemistry, high polymers and plastics, organic intermediates and microbiology. For the present, owing to limitations of space, it is proposed that microbiological studies should be concentrated on corrosion problems, and the Board recommends that throughout its work the Laboratory should pay special attention to the development of new techniques. To implement this programme, expenditure at the rate of £70,000 per annum will be required as well as non-recurrent expenditure on equipment estimated at £20,000; these proposals have been approved by the Committee of the Privy Council for Scientific and Industrial Research.

The Director of the Laboratory in his report details the objectives of the work of the five main research sections in which the scientific staff of twenty-five scientific officers, thirty-three experimental officers and assistants, and twenty-five laboratory assistants has been organised to implement these proposals. There are also two non-sectional groups for exploratory and special work under the Director and Assistant Director, respectively. The present objectives comprise the investigation of corrosion in immersed and atmospheric conditions with the view of the prevention of rusting, tarnishing and corrosion of ferrous and non-ferrous metals in industrial use; the investigation of the microbiological corrosion of metals, particularly in soil, by the influence of bacteria which reduce sulphates, and the investigation of *ad hoc* corrosion problems of industrial importance. In the inorganic field they include the investigation of semi-rare metals, especially their isolation from wastes and low-grade sources, the study and development of physical methods of analysis, and development of micro-analytical methods and other new techniques; in that of high polymers and plastics, the determination of the relations between structure and properties and the preparation of improved plastic materials such as glues and ion-exchange resins; and in the coal tar field, the isolation and identification of tar constituents using the newest methods of separation and analysis, determination of the physical and physico-chemical constants of tar constituents and derived or related substances, and the development of new uses for tar products and their derivatives. The programme also includes the study of high-pressure operations and the production of useful chemicals by such means, and the preparation of compounds capable of polymerization or co-polymerization, particularly those containing silicon.

The Board's report, as well as that of the Director, refers to some of the directions in which progress has been made on these main items during 1946, and the latter report describes the new work done by the non-sectional groups in collaboration with the Agricultural Research Council on the formulation of salves or smears for control of ticks and in devising a new micro method for the rapid determination of D.D.T. Satisfactory results have also been obtained by this section in work on blow fly control. In the Engineering Services, the Corrosion Section has redesigned the coupling used for the slow rotation of specimens so as to ensure positive and concentric alignment of the spindles to the shafts, and a sectional view of the arrangement is included in the report. Investigations of the corrosion-rate of mild steel in salt solution using the high-speed rotor suggest that the nature of the surface finish may appreciably influence corrosion-rates and the reproducibility of results.

The Corrosion of Metals Section has continued to develop both the high-speed and the low-speed rotor techniques for immersed conditions, and with the former technique has investigated the influence of surface preparation on the reproducibility of corrosion-rate and the influence of movement on the corrosion-rate of mild steel in fresh water. Using the new endless belt and beaker type of apparatus for accelerated atmospheric corrosion tests recently noted (*Nature*, **162**, 90; 1948) the corrosion of steel in salt water atmospheres and the effect of impact damage on the corrosion of painted steel have been examined. In collaboration with the Light Division of the National Physical Laboratory, a light-reflexion meter, utilizing the integrating sphere principle, has been constructed, and in collaboration with the British Iron and Steel Research Association the corrosion behaviour of a comprehensive series of low alloy steels is being investigated, using the oxygen-absorption apparatus and the low-speed rotor apparatus. An extensive search is being made for organic corrosion inhibitors more efficient than sodium benzoate. Other work has been concerned with wrapping materials and with vapour-phase inhibitors, as well as with the influence various methods of surface treatment have on the corrosion resistance of mild steel and on the protection afforded by applied coatings.

In the Inorganic Section an attempt is being made to correlate the rare metal content of flue dust and coal ash with that of the fuel from which the dust or ash originated; and methods of extraction of germanium and gallium from flue dust are being studied. The physical chemistry group has given attention to detection and possible estimation of some minor metals by fluorescent technique; and in work on foams for fire fighting, carried out for the Ministry of Home Security, a portable foam meter has been designed which has been very useful in large-scale experiments with petrol fires.

The High Polymers and Plastics Section's comprehensive study of the mechanical properties of reinforced plastics, commenced, jointly with the Engineering Division of the National Physical Laboratory, during the War, has led to a clearer understanding of the relationships existing between the mechanical properties of laminated plastics and the properties of their components. In connexion with the study of weathering properties, a more convenient apparatus is being constructed for the accurate determination of the sorption isotherms of phenol-formaldehyde resins, and the study of the relation between structure and dielectric properties of high polymers is being resumed. A critical review has been made of the literature dealing with the ion-exchange properties of high polymers, and exploratory work commenced on the 'Wofatits'. In the field of adhesives, work has been carried out to improve the setting of resins from monohydric phenols and also of rescorcinol-formaldehyde resins. A cold-setting resorcinol-formaldehyde glue S.R.38, developed in 1944–45, has shown excellent strength and durability. A study has also been made of glues for light alloys.

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* Department of Scientific and Industrial Research. Report of the Chemistry Research Board for the Period 1938–1946, with Report of the Director of the Chemical Research Laboratory for the Year 1946. Pp. iv + 68. (London: H.M. Stationery Office, 1948.) 1s. 3*d*. net.

The Coal Tar Section has completed and brought into operation an all-metal semi-scale fractionating column and has used the column in the preparation of a tar-oil fraction containing the two methylnaphthalenes. A high-vacuum pumping system has been set up to manipulate highly purified and hygroscopic materials. A new expression has been deduced for the relationship between differential changes of composition with boiling-point and applied to the quantitative calculations of the changes in composition with temperature of the azeotrope formed between ethyl acetate and ethyl alcohol. Results obtained in the separation of 2 : 6-butidine, β-picoline and γ-picoline by azeotropic distillation with acetic acid are recapitulated in the report, and a method worked out for the separation of crude xylole fractions has been applied to the examination of a number of crudes of different origin. Some work has been done on the fractionation of lutidine bases, and a method of estimating acenaphthylene in acenaphthene based on ultra-violet absorption spectrography has been applied to the determination of the acenaphthylene content of the crude material formed in the dehydrogenation of acenaphthene.

In the Organic Intermediates Section, preliminary work on organic compounds from boron was not promising; the chief attention was therefore given to the organic compounds from silicon, including the direct synthesis of methylchlorosilanes and their separation by fractional distillation and alcoholysis, and the preparation of organo-silica resins and elastomers. Results obtained in the hydrogenation of metallic salts of fatty acids indicate that lead salts may prove superior to those of copper.

The report of the Chemistry Research Board itself refers to many of these investigations, which are described in somewhat greater detail in the Director's report. The former report also mentions the establishment, on the Board's recommendation, of a joint panel on acetylene chemistry, with the Director of the Laboratory as chairman, between the Department of Scientific and Industrial Research and the Ministry of Supply, to consider the present position of the research on and development and production of acetylene in the United Kingdom and its utilization as an intermediate product in chemical industry. The Board has also recommended the resumption of work on the 'Oxo' reaction between olefins, carbon monoxide and hydrogen to yield aldehydes. Reference to the work of the Laboratory during the war years is very brief; but among its contributions to the war effort thus singled out for mention is the rotor test for assessing the relative value of a variety of protective coatings, the evaluation of anti-freeze materials and the discovery of the inhibitive properties of sodium benzoate, both as an addition to aqueous solutions and when incorporated in wrapping materials. A long series of experiments in the Laboratory showed that suitable carbon blacks could be prepared from indigenous material, particularly coal tar products, and a highly successful foam for fighting petrol fires was also developed from indigenous sources. Much attention was given to the development of a food yeast from *Torula utilis* as an insurance against possible shortage of protein food, and on the basis of this war-time research and development, the Colonial Office has now erected a full-scale plant in Jamaica. The shortage of derris led the Laboratory to collaborate with the Agricultural Research Council in the development of products for the control of animal parasites, and a satisfactory D.D.T. emulsion was finally formulated for the control of blow-fly on sheep.

Lists of papers published from the Laboratory during 1946 and of British patents and patent applications granted or filed during the year are appended to the report.

A summary account of current work at the Laboratory was published in *Nature* of July 17, p. 90.

PRODUCTION OF INDOLE BY *ESCHERICHIA COLI*

By Dr. EDWIN A. DAWES

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THE mechanism of the production of indole by *Escherichia coli* has attracted the attention of many workers since Hopkins and Cole[1] first demonstrated that the precursor of indole is tryptophan. The problem is an intriguing one among the bacterial degradation of amino-acids, inasmuch as fission of a carbon-carbon bond occurs at a position in the molecule remote from the amino- and carboxyl-groups, instead of the more usual carbon-nitrogen split. It became even more intriguing when an exhaustive survey of theoretically possible intermediates in the reaction failed to give rise to indole in the presence of the organism.

In 1922, Frieber[2] described a series of growth experiments in which tryptophan in the growth medium was replaced by various indole derivatives, and he found that no indole was produced from 3-indolecarboxylic acid, 2 : 3-indoledicarboxylic acid, skatole, 3-indolealdehyde, 3-indoleacetic acid, β-3-indolepyruvic acid and β-3-indole-ethylamine. In spite of the failure of 3-indoleacetic acid to give rise to indole he postulated that the reaction occurred in two stages, namely: (1) formation of 3-indoleacetic acid; and (2) the breakdown of this compound to indole; only the former occurring in the presence of fermentable carbohydrate.

Harden[3], in 1930, gave the reaction as follows: Tryptophan → β-3-indolepropionic acid → 3-indoleacetic acid → indole.

Extensive work on this subject appeared in 1935 by Woods[4] who, using the washed viable cell suspension technique, demonstrated that five atoms of oxygen are required for the complete oxidation of one molecule of tryptophan, and that *D*-tryptophan is not metabolized; and he presented strong presumptive evidence for the anaerobic production of β-3-indolepropionic acid (cf. Hopkins and Cole[5]). He also investigated the action of cell suspensions of *Esch. coli* on various possible intermediates[6], and he was forced to reject Harden's hypothesis[3] and also that of Raistrick[7] based on analogy with histidine metabolism. Compounds tried included those used by Frieber[2] and also β-3-indoleacrylic acid, all of which gave no indole production. β-3-Indolepyruvic acid, but only in the presence of ammonia, gave 10 per cent production of indole, presumably due to tryptophan being first formed.

Again in 1935, Happold and Hoyle[8], simultaneously and independently, using non-viable cell suspensions, obtained similar results to Woods with the possible intermediates, and they gave the name 'tryptophanase' to the enzyme complex which is responsible for the reaction. They went on to show that in the presence of fermentable carbohydrate the failure to produce indole is presumably due to the non-production of the tryptophanase system[9]. This observation was afterwards verified by Evans, Handley and Happold[10], in reply to criticism by Fildes[11], and they later showed that complete inhibition of indole production only occurs in the presence of phenylalanine and tyrosine[12].

Meanwhile, Baker and Happold[13] had been concerned with the determination of essential structural conditions necessary for the reaction to occur. By systematically modifying the tryptophan molecule, it was shown that an intact side-chain is necessary for indole production, and (later) that the =NH group of the indole nucleus must be unsubstituted[14]. On the basis of this work, a tentative mechanism for the reaction was suggested involving reductive fission of an intact alanine side-chain.

However, in 1942, Krebs, Hafez and Eggleston[15] suggested that β-*o*-aminophenylacetaldehyde is the effective indole-producing intermediate. They assumed that oxidation of the tryptophan molecule yields β-*o*-aminophenylethanol, which then condenses spontaneously to form indole. This was not substantiated, and the Leeds workers[14] showed that with β-*o*-aminophenylethanol the best results represented only 22 per cent conversion to indole in 18 hours, whereas with tryptophan the yield was 90 per cent in less than 2 hours; furthermore, dimedon completely inhibited the former reaction but was without effect on the tryptophan-indole reaction.

The next hypothesis concerning the mechanism of the reaction was put forward by Tatum and Bonner[16] in 1944. From a study of the way in which a mutant strain of the mould *Neurospora crassa* synthesizes tryptophan from indole and serine, they postulated that the breakdown of tryptophan to indole by *Esch. coli* is a reversal of this reaction, that is, hydrolytic fission to yield indole and serine. In support of this, experiments were quoted in which inhibition of indole production is produced by the addition of serine to tryptophan in the presence of sterile washed suspensions of the organism, the effect being specific and a function of the concentration; the biosynthesis of tryptophan from indole and serine was also claimed. The biosynthesis of tryptophan by *Esch. coli* was not verified by Fildes[17] or the present author.

Since all the 3-indolyl derivatives tried failed to give rise to indole, the hypotheses of Baker and Happold[13] and Tatum and Bonner[16] involving fission of the intact side-chain, as alanine and serine respectively, were eminently attractive. Dawes, Dawson and Happold[18] conducted an analytical investigation of the reaction employing paper chromatography, and making use of Dawson's[19] observations of the effect of 'Mepacrine' on the tryptophanase activity of *Esch. coli*. Dawson showed that under the influence of 'Mepacrine' there is no oxygen uptake by washed cells over an initial 60 minutes while indole is produced in reduced amount. The possibility of oxidation of any intermediate in these circumstances is much reduced, and under such conditions alanine was detected whereas serine was never found, thus strengthening Baker and Happold's hypothesis. Attempts to produce alanine by chemical reductive fission of tryptophan using Raney nickel catalyst failed, although indole was produced. This may not be due to true reductive fission but rather the catalytic effect of a heavy metal on tryptophan, as in Herzfeld's[20] experiments, and more recently in the work of Kuiken, Lyman and Hale[21].

The inhibitory action of serine on indole formation was shown to depend on the degree of saturation of tryptophanase with tryptophan, and to be not simply a function of concentration; while the possibility of a phosphoclastic fission occurring to yield indole and serinephosphoric acid was examined by paper chromatography and rejected.

Dawes, Dawson and Happold[22] obtained the enzyme in the cell-free state and investigated the action of various recognized inhibitors[23,24] on it. In this way evidence was obtained for the presence of carbonyl and iron-containing components, while spectrophotometric analysis furnished evidence of a nicotinamide system; iron was detected by spectrochemical analysis. The enzyme could be resolved by dialysis, and riboflavin was shown to be present in both apoenzyme and dialysate by microbiological assay. Reactivation of the apoenzyme was achieved with pyridoxal phosphate, riboflavin and diphosphopyridine nucleotide. Crude enzyme extracts performed the reaction with consumption of five atoms of oxygen, but the partially purified enzyme produced indole anaerobically as recorded by Wood *et al.*[25]. Such samples required only pyridoxal phosphate as coenzyme, and hence riboflavin and diphosphopyridine nucleotide appear to be concerned in the further oxidation of the pyruvic acid first formed; purification removes the enzyme(s) concerned in this.

However, that alanine is not the normal intermediate in indole production was shown by Wood, Gunsalus and Umbreit[25], who partially purified the enzyme by ammonium sulphate fractionation and found that it was then resolved and could be reactivated by pyridoxal phosphate. This enzyme would not deaminate alanine or serine, while still producing indole from tryptophan, and hence neither could be intermediates in the reaction; the products of the reaction are one mole each of indole, pyruvic acid and ammonia, and no oxygen is taken up in the process.

It seems a pity that Wood *et al.* call the enzyme which effects the fission 'tryptophanase', when this term was originally used to connote the complex performing the complete oxidation. An iron-containing system appears to function in the overall oxidation reaction, and it is significant that verdoperoxidase and cytochrome *c* both stimulate indole production.

The Michaelis constant of tryptophanase is given as $2{\cdot}5 \times 10^{-5}$ by Wood *et al.*, but they state that the half maximum reaction-rate is obtained with 35 μgm. tryptophan per ml. and this gives a K_M value of $1{\cdot}7 \times 10^{-4}$ and is more in accord with the author's figure of $4{\cdot}1 \times 10^{-4}$.

The fact that indole is formed anaerobically raises interesting speculation on the claims of Hopkins and Cole and Woods that β-3-indolepropionic acid is produced in anaerobic culture; strain differences may well account for this. However, the search for intermediates in the reaction has now been cleared up by Wood *et al.*, although α-aminoacrylic acid may be the primary fission product (this would decompose spontaneously to pyruvic acid and ammonia in aqueous medium), and the reaction is a balanced one from the oxido-reduction point of view. The detection of alanine in the presence of 'Mepacrine' may be due to a diversion of the normal reaction path, such as hydrogenation of α-aminoacrylic acid, or to reamination of the pyruvic acid product.

[1] Hopkins, F. G., and Cole, S. W., *J. Physiol.*, **27**, 418 (1901).

[2] Frieber, W., *Zentr. Bakt.*, I (orig.), **87**, 254 (1922).

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EXCITATION PROCESSES IN MOLECULAR NITROGEN

By R. W. NICHOLLS

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IN controlled electron experiments it has been usually assumed[1] that in the emission of the triplet bands of molecular nitrogen, transitions to the upper levels of the band systems concerned come about directly as a result of collisions of the first-kind between molecules in the ground-state $X^1\Sigma_g^+$ and fast electrons. A further assumption made is that the energy values of the upper states of the bands concerned are the voltages at which they respectively appear when excited by an electron beam of controlled energy. These assumptions lead to the placing of the triplet-levels approximately 2 volts higher than the normally accepted values based on reliable spectroscopic evidence[2]. In particular, the $A^3\Sigma_u^+$-level would be placed about 2 volts above the value suggested by the analysis of the Vegard – Kaplan bands $A^3\Sigma_u^+ \rightarrow X^1\Sigma_g^+$.

The results of these experiments[1], which are reasonably consistent, are summarized in the table on p. 232. It would seem, therefore, that the assumptions mentioned are in error. This view is further strengthened by the following facts.

(1) Only singlet systems are obtained in absorption experiments in nitrogen, namely, the Lyman – Birge – Hopfield and Birge – Hopfield bands. The triplet bands do not appear in absorption, and consequently as electron and photon collisions with molecules generally result in the same excitation, it would be expected that electron collisions with ground-state molecules would excite the singlet- rather than the triplet-levels.

(2) The multiplicity change (singlet-triplet) involved in direct excitation of the triplet-levels from the singlet ground-state makes such a transition forbidden, and therefore a relatively rare event, both in the case of electron collisions and of photon collisions.

It is the purpose of this note to suggest a more probable excitation process which accounts for the observed experimental results without incurring an artificial raising of the triplet-levels, and which violates neither the selection rules nor the Franck – Condon principle.

It is suggested that primary excitation by collisions between ground-state molecules and electrons results in the population of the singlet-levels: $a^1\Pi$ and b. b[3] is a group of eight levels between 12·5 and 14 volts (the upper states of the Birge – Hopfield and Gaydon bands), which for the purposes of this discussion may be considered together. By analogy with the atomic case[4], we expect the excitation probability function of a level for non-intercombination (singlet-singlet) transitions to rise from zero at the energy of the level in question to a broad maximum somewhat above it. A singlet-level will therefore be most populated when the exciting electrons have the energy corresponding to this maximum. Population of the triplet-levels can then come about by intercombination collisions of the second kind between slow electrons and the molecules in the excited singlet-states. For such second-kind collisions to be effective, two considerations have to be taken into account: (1) The balance between the life-time of a molecule in an excited state and the collision frequency of slow electrons. This is governed by excitation conditions and depends greatly on pressure. (2) The balance between the transition probability and the probability that, on collisions between an excited molecule and a slow electron, intercombination transitions of the second kind will occur. This is governed by molecular constants only.

An analysis which has been made of the excitation kinetics of this mechanism shows it to be more likely than the one previously assumed. Details of this analysis will be published shortly.

This mechanism was suggested primarily by a comparison of the energies of the singlet-levels with the electron energies at which the triplet bands appeared (see table). The appearance potential of the first positive bands, *after correction by extrapolation to the* (0,0) *band*, is approximately 9·5 volts, which is about the value for the maximum excitation probability of the $a^1\Pi$-level. The appearance potential of the second positive bands is approximately 13 volts, which again is very near the maximum probability of excitation of the b-levels. The fact that the first positive appears at approximately 9·5 volts on the excitation of the $a^1\Pi$-level, and that it is not fully developed until the second positive bands appear at approximately 13 volts, reaching a maximum with

	Energy-levels					
	Singlets	Energy (volts)	Triplets	Band systems	Appearance potentials (volts)	Remarks
N_2	$X^1\Sigma_g^+$ (ground-state)	0		$A^3\Sigma_u^+ \rightarrow X^1\Sigma_g^+$ Vegard – Kaplan		Forbidden transition
		6·2	$A^3\Sigma_u^+$			
		7·3	$B^3\Pi_g$	$B^3\Pi_g \rightarrow A^3\Sigma_u^+$ First positive	9·3 (S), 9·4 (V), 9·5 (D)	Fully developed on excitation of second positive, maximum intensity at $\sim$ 15 volts
	$a^1\Pi_g$	8·5				
		11	$C^3\Pi_u$	$C^3\Pi_u \rightarrow B^3\Pi_g$ Second positive	12 (D), 13 (S), 13·16 (T, W), 13·4 (V)	Maximum intensity at $\sim$ 15 volts
		12·8	$D^3\Sigma_u^+$	$D^3\Sigma_u^+ \rightarrow B^3\Pi_g$ Fourth positive	15 (D)	Maximum intensity at $\sim$ 20 volts
	b (8 levels)	$\begin{cases} 12·5 \\ 14 \end{cases}$				
	Doublets					
N_2^+	$X'^2\Sigma_g^+$	15·6		$B'^2\Sigma_u^+ \rightarrow X'^2\Sigma_g^+$ First negative	18 (D), 19 (S)	Maximum intensity at $\sim$ 80 volts
	$B'^2\Sigma_u^+$	18·7				

(S), Sponer; (D), Duncan; (T, W), Thompson and Williams; (V), Vegard.

them, strongly suggests that the primary population of the B^3 -vibrational-levels, below the $a^1\Pi$-level, is due to collisions of the second kind between slow electrons and molecules in the $a^1\Pi$-state, while the secondary population of the $B^3\Pi$-levels, especially those which lie above the $a^1\Pi$-level, results from the emission of the second positive bands $C^3\Pi \rightarrow B^3\Pi$. A further factor contributing to the population of the $B^3\Pi$-levels, when b is excited, would be collisions of the second kind between slow electrons and molecules in the b-state. The fourth positive system $D^3\Sigma \rightarrow B^3\Pi$ appears at 15 volts when certain of the b-levels which lie above the $D^3\Sigma$-level become populated, and reaches a maximum intensity at approximately 20 volts. Owing to the metastability of the $A^3\Sigma$-level, numerous collisions of the second kind with slow electrons will be probable. A radiationless $A^3\Sigma \rightarrow X^1\Sigma$ transition will therefore be more likely than the emission of the Vegard – Kaplan bands in most usual forms of discharge in nitrogen. The first negative system $B'^2\Sigma \rightarrow X'^2\Sigma$ of N_2^+ will be excited directly by first-kind collision between ground-state $X^1\Sigma$ N_2 molecules and fast electrons.

The mechanism thus adequately accounts for the observed excitation potentials in terms of known levels of nitrogen. Further facts in its favour are:

(1) It is in accordance with the Franck – Condon principle in initial excitation.

(2) There is no change in multiplicity in the initial excitation.

(3) The recently proposed g symmetry of the $a^1\Pi$-level[5] renders that level metastable, thus raising the excitation life-time and making collisions of the second kind even more probable. Although the metastability tends to make the initial excitation less probable, the fact that the singlet bands appear in absorption shows that it can, and does, occur with a greater probability than the singlet-triplet excitation. The long path-length required for this absorption to occur provides experimental evidence for the metastability, as was pointed out by Herzberg[5].

The above ideas are a result of work attempting to correlate spectroscopic and electrical observations on a glow discharge in nitrogen. Should the suggested mechanism prove to be correct, it may have an important bearing on auroral excitation, since many current theories of the aurora include direct singlet-triplet excitation of neutral nitrogen, N_2, by electrons.

I should like to express my grateful thanks to Dr. R. W. B. Pearse for valuable discussions on this subject.

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INTERNATIONAL GEOLOGICAL CONGRESS

PREPARATIONS are now well advanced for the Eighteenth Session of the International Geological Congress. So far about 1,500 geologists, representing some sixty countries, have registered as members. The programme of long excursions associated with the Congress begins on August 7.

The Session will be formally inaugurated at a meeting of the General Assembly in the Royal Albert Hall on August 25, when Mr. Herbert Morrison will welcome the delegates and members on behalf of the British Government, and Sir John Anderson, honorary president of the General Organising Committee, will speak on behalf of that Committee. Prof. H. H. Read, president of the Geological Society of London, is president-designate of the Session.

During the following days there will be an extensive series of sectional meetings, at which about two hundred and fifty papers, of which only a few can be mentioned in this notice, and covering a very wide range of topics, are due to be presented.

In the Section on Problems of Geochemistry, questions connected with the development and migration of magmas and the genesis of ore deposits, the geochemical history of single elements, and the origin of serpentines will be discussed by distinguished contributors, including Dr. N. L. Bowen of Washington, Prof. H. von Eckermann of Stockholm, Prof. P. Niggli of Zurich and Prof. W. Wahl of Helsingfors. In another petrological section, devoted to "Metasomatic Processes in Metamorphism", the 'magmatists' and the 'transformists' will present contrasting views on the respective importance of magmatic and hydrothermal penetration and of solid diffusion in the process of granitization and of metamorphism in general. The contributors include Prof. P. Eskola of Finland, Prof. N. H. Magnusson of Stockholm, Prof. E. Wegmann of Neuchatel, Prof. H. G. Backlund of Uppsala, and Prof. Ian Campbell of California.

Stratigraphical and palæontological problems will be discussed by several sections. The Section on Rhythm in Sedimentation will include papers by Prof. R. C. Moore, Dr. H. R. Wanless, and other American authors on cyclic sedimentation in the Palæozoic Rocks of the United States, and by Prof. G. F. Troedsson of Stockholm and other authors on rhythm in the Mesozoic and Tertiary sediments of Europe. Prof. A. Renier of Brussels, Dr. S. J. Dijkstra of Heerlen, Prof. Y. C. Sun of Peiping, Dr. J. J. Gorsky of Leningrad, and Dr. F. K. G. Mullereid of Mexico City are among contributors who will deal with general and regional problems of facies correlation in the Section on Faunal and Floral Facies and Zonal Correlation. The correlation of continental vertebrate-bearing rocks will be discussed in a separate section, and the overseas contributors include Dr. C. Teixeira of Lisbon, Mlle. M. Richard of Algiers, Dr. R. A. Stirton of California and Prof. Erik Stensiö of Stockholm. This Section will also hold a joint meeting with the Section on the Pliocene–Pleistocene Boundary. The latter will attempt to reach an agreed definition of the lower limit of the Pleistocene System by synthesis of the views of specialist contributors, including Dr. L. S. B. Leakey of Kenya, Dr. A. Halicka of Warsaw, Dr. D. N. Wadia of India, Prof. van der Vlerk of Leyden, Prof. C. Migliorini of Florence and Prof. C. Arambourg of Paris. Another section will discuss the relation between earth movements and organic evolution, and includes papers by Drs. K. Zapletal and L. V. Cěpek of Czechoslovakia, Academician V. A. Obruchev of Moscow, and Dr. A. Chavan of Nanterre.

An interesting field of inquiry is covered by the Section on the Geology of Sea and Ocean Floors. In this a number of American geologists will describe recent work on submarine geology of the Northern Marshalls, including recent borings on Bikini Atoll; and Prof. C. Francis-Bœuf of Paris will speak of the use of the 'Bathyscaphe-Piccard-Cosyns' in submarine studies. Other contributors are Prof. R. M. Field of Princeton, Prof. P. H. Kuenen of Groningen, and Dr. J. S. Lee of Nanking.

Three sections are specifically devoted to applied geology. A symposium on the geology, paragenesis and reserves of the ores of lead and zinc has been prepared under the editorship of Dr. K. C. Dunham and will be discussed by a special section. Its assessment of world reserves suggests that little more than about nineteen years production of lead ores and twenty-four years production of zinc ores can be foreseen. The Section on the Geological Results of Applied Geophysics will deal with recent magnetic, electrical, gravitational and seismic work on diverse problems in many countries. The Section on the Geology of Petroleum will include a wide range of papers on general and regional subjects, among which recent work in the oilfields of the Middle East is prominent.

There is also a section in which a great variety of miscellaneous papers will be presented. Among these, tectonic studies predominate, and the authors include Prof. A. Noe-Nygaard of Copenhagen, Prof. O. Holtedahl of Oslo, Prof. A. Demay of Paris, and Dr. A. Heim of Zurich.

The Association des Services Géologiques Africains will hold a series of open meetings at which a synthesis of research on African geology during the last decade will be attempted, and problems of correlation within the African continent will be discussed. The International Palæontological Union will also hold open meetings, including one specially devoted to the stratigraphical use of Foraminifera and another to the nomenclature of fossils. A series of special meetings on the mineralogy and geology of clays has been organised in conjunction with the Clay Minerals Group of the Mineralogical Society.

Three major items in the technical programme are special addresses on the structural history of Britain, by Sir Edward Bailey and Prof. O. T. Jones, who will respectively deal with Scotland and with England and Wales; and a colour film and lecture on the new Mexican volcano Paricutin, presented by Dr. F. H. Pough of the American Museum of Natural History.

During the period of the Session receptions will be given by H.M. Government, by the Geological Society of London, the University of London and a number of other authorities and institutions.

A series of ninety-six day and half-day excursions demonstrating the geology of south-eastern England will take place during the period August 20–September 4. After the closing meeting of the General Assembly on September 1, there will also be another series of seventeen long excursions covering practically the whole of Great Britain and Eastern Ireland.

CONDENSATION OF INTERSTELLAR MATERIAL INTO STARS

F. HOYLE has suggested (*Mon. Not. Roy. Astro. Soc.*, **107**, 4; 1948) a criterion for determining the degree of condensation of interstellar material into stars. Observational data for disk-shaped nebulæ, such as *M* 31 and *M* 33, suggest that only a small fraction of the total mass is in the form of stars, whereas Oort has found that the elliptical nebula NGC 3115 must be almost entirely composed of stars. The paper is devoted to a consideration of the factors that determine the fraction by mass of a nebula that is condensed into stars, and a new method for attacking this problem is developed which suggests that condensing stars with masses exceeding 0·2 that of the sun must become rotationally unstable before reaching the main sequence stage, and such stars must evolve by ejecting material until their masses are reduced below the critical value. Present available information suggests that the ejected material is thrown off to infinity, and hence stars forming in the main body of nebulæ such as *M* 31 or *M* 33 have masses less than 0·2 that of the sun at the time of condensation to the main series state; but the masses can afterwards increase by accretion of interstellar matter. The application of the criterion shows that we should expect both the nuclei of disk-shaped nebulæ and the elliptical nebulæ to be almost entirely condensed, but the main body of a disk-shaped nebula such as *M* 31 would be largely uncondensed. The highly condensed state of the nuclei of disk-shaped nebulæ and elliptical nebulæ receives an important application in determining the ages of the extragalactic nebulæ, and Hoyle shows that these are of the order 5×10^9 years.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Plant Pathologist (Scientific Officer Grade), and a Field Officer (Experimental Officer Grade), in connexion with potato storage investigations at the University of Nottingham, Sutton Bonington—The Secretary, Agricultural Research Council, 6a Dean's Yard, London, S.W.1 (August 14).

Charles Brotherton Scholarship and United Kingdom Gas Corporation Scholarships in the Department of Coal Gas and Fuel Industries with Metallurgy—The Registrar, The University, Leeds 2 (August 14).

Technical Assistant (Grade B) in the Botany Department, chiefly for mycological work—The Secretary and Registrar, University College of North Wales, Bangor (August 14).

Assistant Lecturer (Grade III) in Geology—The Secretary, The University, Edmund Street, Birmingham 3 (August 14).

Research Fellow to lead a research group engaged on work connected with the chemical constitution of coal, and two Research Workers—The Secretary, The University, Birmingham 3 (August 15).

Lecturers in (*a*) Physics, with subsidiary Mathematics, (*b*) Electrical and Mechanical Engineering, in the Ministry of Supply School of Electronics, Malvern—The Chief Superintendent, Telecommunications Research Establishment, Great Malvern, Worcs. (August 16).

Lecturer in Civil Engineering—The Registrar, The University, Leeds 2 (August 16).

Lecturer in the Department of Geology with special qualifications in Mineralogy and Petrology—The Registrar, The University, Manchester 13 (August 20).

Principal Scientific Officer to lead a team engaged in experimental and design work, involving problems of pilot plant for chemical engineering, heat transfer and development of special instrumentation and remote control methods, and Senior Scientific Officers for experimental and design work, involving similar problems, in the Engineering Division of the Atomic Energy Research Establishment, Harwell, Berks, under the Ministry of Supply—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W., quoting No. 2205 (August 26).

Lecturer (Grade IIc or IIb) in the Department of Chemical Engineering—The Secretary, The University, Edmund Street, Birmingham 3 (August 30).

Lecturer in Psychology in the University of Sydney—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W. 1 (August 31).

Demonstrators in Biology and Chemistry—The Secretary, Royal Veterinary College and Hospital, Royal College Street, London, N.W.1 (August 31).

Physicist to the Department of Radiotherapy—The Superintendent, Guy's Hospital, London, S.E.1 (August 31).

Senior Organic Chemist in the Biochemistry Section for work on the organic constituents of fruit-bearing plants—The Secretary, East Malling Research Station, East Malling, Maidstone, Kent (August 31).

Lecturer in Mathematics—The Registrar, University College, Southampton (September 4).

Lecturer or Assistant Lecturer in Mathematics, with special qualifications in Applied Mathematics—The Registrar, University College of Wales, Aberystwyth (September 4).

Tutorial Studentships in Electrical Engineering, and Organic Chemistry in the Department of Physiology—The Registrar, King's College, Strand, London, W.C.2 (September 13).

Director of Museums—The Town Clerk, City Chambers, Glasgow, W.2 (September 15).

Professor of Civil Engineering in Natal University College—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (September 15).

Mullard Readership in Electronics at the Imperial College of Science and Technology—The Academic Registrar, University of London, Senate House, London, W.C.1 (September 15).

Lecturer in Graphics and Machine Drawing, a Lecturer in Entomology, a Senior Lecturer in Organic Chemistry, and a Senior Lecturer in Inorganic Chemistry—The Registrar, Rhodes University College, Grahamstown, South Africa (September 15).

Senior Lecturer in the Department of Botany—The Registrar, The University, Manchester 13 (September 17).

Readership in Mathematics at Birkbeck College—The Academic Registrar, University of London, Senate House, London, W.C.1 (September 22).

Readership in Civil Engineering at King's College, Strand—The Academic Registrar, University of London, Senate House, London, W.C.1 (October 1).

Economic Botanist in the Department of Agriculture, British Guiana, to take charge of the Central Rice Station—The Director of Recruitment, Colonial Service, 15 Victoria Street, London, S.W.1.

Technician in Chemistry Department—The College of the Pharmaceutical Society, 17 Bloomsbury Square, London, W.C.1.

Ecologist in the Tsetse Control Department, Government of Uganda—The Director of Recruitment, Colonial Service, 15 Victoria Street, London, S.W.1.

Controller of Agriculture in Cyrenaica—The War Office, C.4(E), Room 447, Metropole Buildings, Northumberland Avenue, London, W.C.2.

Entomologists for advisory and research work on crop pests and special research on the sisal weevil, on the staff of the Government of Tanganyika—The Director of Recruitment, Colonial Service, 15 Victoria Street, London, S.W.1.

Lighting Engineers, Heating and Ventilation Engineers, and Technical Research Officers, in the Factory Standards and Design Branch of the Australian Department of Labour and National Service—Mr. T. C. Graham, Australia House, Strand, London, W.C.2.

Game Ranger in Tanganyika, and a Game Warden in the Gold Coast—The Director of Recruitment, Colonial Service, 15 Victoria Street, London, S.W.1.

Head of the College—The Clerk, National College of Rubber Technology, Northern Polytechnic, Holloway Road, London, N.7.

Chief Computor in the Survey Department, Nigeria—The Director of Recruitment, Colonial Service, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

Lecturer in Mathematics in the University of Otago, Dunedin—The High Commissioner for New Zealand, 415 Strand, London, W.C.2.

Senior Laboratory Steward (chemistry and biology)—The Bursar, Merchant Taylors' School, Sandy Lodge, Northwood, Middx.

Research Assistants (2, men or women) in the Department of Chemistry for work in physical-organic chemistry—The Professor of Chemistry, Royal Holloway College, Englefield Green, Surrey.

Lecturer or an Assistant Lecturer in Geology—The Registrar, The University, Nottingham.

Assistant Manager of the acid and ammonia works at Phoenix Wharf, East Greenwich—The Secretary, South Metropolitan Gas Co., 709 Old Kent Road, London, S.E.5, endorsed 'Assistant Manager—Chemical Works'.

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

An Index to Modern Remedies. By William Mair. Fourth Series. Pp. 68. (Glasgow: The *Scottish Chemist*, 1948.) 3*s*. [245

Scottish Council (Development and Industry). Report of the Committee on the Chemical Industry of Scotland. Pp. 39. (Edinburgh: Scottish Council, 1948.) 2*s*. [255

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Other Countries

Science and Public Policy. Vol. 1: A Program for the Nation. A Report to the President by John R. Steelman. Pp. x+73. 20 cents. Vol. 2: The Federal Research Program. A Report to the President by John R. Steelman. Pp. viii+318. 55 cents. Vol. 3: Administration and Research. A Report to the President by John R. Steelman. Pp. viii+324. 55 cents. Vol. 4: Manpower for Research. A Report to the President by John R. Steelman. Pp. viii+166. 35 cents. Vol. 5: The Nation's Medical Research. A Report to the President by John R. Steelman. Pp. x+118. 25 cents. (Washington, D.C.: Government Printing Office, 1947.) [275

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SCIENCE AND ITS SOCIAL RELATIONS

THE resolutions adopted by the Committee on Science and its Social Relations of the International Council of Scientific Unions at its meeting in Paris during June 15–16, and which have been forwarded to the scientific press and to scientific institutions, reflect faithfully the trend of thought among a considerable body of scientific men throughout the world. The recent review of the work of the Rockefeller Foundation in 1947 by its president, Dr. Raymond B. Fosdick, gives witness to similar views. At this meeting, Dr. C. H. Desch was the only British representative, Prof. F. J. M. Stratton, who was chairman during 1937–48, having retired on appointment as deputy scientific adviser to the War Office. The resolutions were the outcome of extensive discussions on the method of working to be adopted by the Committee and on its future programme of work, and in this connexion the first resolution affirms the opinion of the Committee that the most urgent problems of the social relations of science are to-day, first, the dangers threatening science from the fact that research in large measure has become dependent on military sources and on industry for its financing, and secondly, the way in which the results of science are actually introduced into society.

Both these problems were emphasized by the Committee in the circular letter issued in October 1947, and the first is the subject of keen debate in the United States at the present time. While the extension of Government research is regarded with a measure of distrust, a couple of recent articles indicate like concern at the growing practice of using university laboratories for the conduct of research sponsored by industry, and urge that the support which industry gives to university research should not be tied to the financing of particular projects, beyond designating a broad general field of research. Mr. S. Tout condemns outright the arrangements announced in the *New York Times* last January between seven industrial firms and the University of Chicago in regard to atomic research as not in the public interest. He urges that universities and like institutions should discontinue research for private enterprise and limit themselves to research for the public benefit.

The position in this matter varies from one country to another, and there does not appear to be any reason for believing that in Great Britain there is at present any serious danger that the direction of academic research is being deflected by industrial endowment. Endowments, such as the research fellowships established by Imperial Chemical Industries, Ltd., or Turner and Newall, Ltd., are entirely free from such restrictions other than that the research is to be conducted in some specific branch of science. Any malaise in Britain is rather related to the dangers arising from the subvention of research from military sources to which the Committee on Science and its Social Relations directs attention in its third resolution. The Committee believes that the increasing influence of the military on scientific research will lead sooner or later through its secrecy restrictions to the abrogation of the traditional freedom of expression and of publication, and will result in directed research not planned primarily for the benefit of science and mankind but rather for its destruction.

While it is possible that the fears entertained on this point are exaggerated, it seems just as certain that the Atomic Energy Commission must concern itself with the social implications of atomic power; for it is on that matter that liberty and equalitarian democracy become incompatible. Dr. M. H. Stone, of the University of Chicago, pointed out last year in *Science* (**105**, 507; 1947) that the Commission would have to concern itself with many questions which fall within the domain of the social sciences, and that it is important that similar attention should be given to the social effects of many other innovations flowing from our laboratories. Dr. Fosdick, in the Rockefeller Foundation report referred to above, clearly had the same point in mind when, in discussing the unity of science, he referred to the way in which the activities of the Institute for the Unity of Science in New York, towards which the Foundation made a grant in 1947, included research which cuts across the traditional demarcation lines of specialized disciplines and departments, the utilization of new knowledge in logic, the study of meaning and how it is communicated, and research on the philosophical, psychological and sociological backgrounds of science.

More important, however, in this connexion is the stress which Dr. Fosdick lays elsewhere in his report on the dependence of the health of the intellectual life of the world upon the free and unhampered exchange of ideas and personnel between universities and research institutions in all countries. Achievement is usually the result of the sustained thinking of many minds driving toward a common goal in many countries. The creative spirit of man, Dr. Fosdick once more reminds us, cannot be localized or nationalized. Ideas are starved when they are fenced in behind frontiers, and barricaded research in the long run leads to intellectual stagnation.

This is why Dr. Fosdick considers that the heavy concentration in the United States of research in atomic physics is unfortunate. However necessary for the time being from the security point of view, from the point of view of the growth of knowledge the arrangement is unhealthy. All knowledge is so interlocked that we cannot control research on the destructive aspects of atomic energy without at the same time interfering with world-wide research on its beneficent possibilities. Those American men of science who suggested the postponement indefinitely of the industrial development of atomic power not only recognized the impracticability of separating the development of nuclear power for industry from the growth of atomic-bomb power, but also that in the harnessing of forces which might bring incalculable benefit to mankind, knowledge could be retarded through lack of the cross-fertilization brought about by the exchange of knowledge.

Dr. Fosdick observes further in this connexion that in the history of modern science no single country by itself has ever had the intellectual resources or the imagination to bring to full fruition all the potentialities of a new idea, and he comments on the unfortunate growing isolation of the scientific workers and scholars of Eastern Europe. The high level of creative research of the distinguished mathematician of the Soviet Union, her imaginative work in biomedicine cannot be maintained if the Soviet Government prevents direct and intimate relations with workers in these same fields in other parts of the world. Isolationism is a blight which saps the vitality of everything it seeks to preserve.

Set in this context, the statement issued in Great Britain in July by the Atomic Scientists' Association seems lamentably weak and compares poorly with the report "Policy at the Crossroads" in which the U.S. State Department has recently summarized the efforts of the United States and other Governments during the last two years to secure the adoption of an effective system for the control of atomic energy. Undoubtedly it is clearer than it was in 1946 that the sources of disagreement between the major Powers are so deep that the institution and working of a control scheme are much more difficult than at first supposed, and that there is little chance of agreement at the moment on the lines of the Lilienthal proposals or on any more limited scheme. The United States Government is naturally enough unwilling to abandon its lead in atomic weapons without a complete system of inspection and control which would ensure that no other country was building up such armaments to use against America. On the other hand, the Soviet Union believes that in any control authority acceptable to the United States, the countries voting with the U.S.S.R. would be in a minority and that the development of atomic energy in the U.S.S.R. would pass under foreign direction. The attitude of Soviet Russia may also be determined by the view that any complete scheme of inspection would give the outside world information of strategic value about the location of their industry.

While, therefore, a substantial change in international relations is necessary before any such plans can be revived with any hope of success, the Council of the Atomic Scientists' Association quite rightly records its continuing belief that some form of international control is the most desirable ultimate solution of the problem of atomic weapons. The Council believes that the solution can now be sought only through the constant promotion of all measures designed to make war less likely, and to reach a settlement between East and West. In its anxiety to avoid taking sides, however, the Council of the Association has become vague. The commendable attempt to avoid political bias is carried too far when it avoids passing judgment on the facts. It is scarcely an act of partisanship to point out that the man of science in the modern totalitarian State is essentially a servant of the State, and that it is treason, as indeed the law promulgated last year in the U.S.S.R. illustrates, for him to divulge any knowledge whatever, save as the State allows. The Association does less than justice to the respect of British and American scientific workers for the full tradition of scientific freedom, or to their freely expressed impatience every restriction imposed on them in the name of security. No instinctive inhibitions will hamper British or American scientific workers in the exchange of scientific information; but it is at least arguable that collaboration as suggested by the Atomic Scientists' Association is more likely to promote, for the present, a one-way traffic to the disadvantage of the Western democracies. That is undoubtedly the real reason why the American–Soviet Science Society has had to cease its efforts to promote the interchange of scientific ideas between American and Soviet scientific workers. If an improvement in political relations is a first condition of cultural intercourse, the Atomic Scientists' Association may well have rejected a shade too cursorily the proposal for a moratorium in the development of atomic energy, or that a control scheme should be established of those nations which were willing to submit to the essential inspection and other measures.

No one would pretend that such a partial control scheme would eliminate the need for secrecy, though it might limit the area, and it could not well intensify the suspicion which already exists between East and West. What it could do is demonstrate the practicability of inter-nation control over an area in which political conditions and relations gave the control a chance to operate, and in this way it might permit international control in the full sense to be hieved at an earlier date once the political situation he world as a whole had become favourable. The Committee on Science and its Social Relations does not touch on this specific problem; but in more general terms points out that the actual problems involved in all social relations of science are problems concerning men's attitude to scientific knowledge and to its application, in particular, to the power given by science.

For this reason the Committee proposes to address itself to a number of scientists, sociologists, persons prominent in educational work, and others to ascertain their opinions on the measure in which the methods of international scientific work contribute to the creation of an international spirit and to the maintenance of peace and on the ways in which scientific organisations and scientific men could intensify their activities for the maintenance of peace. This inquiry should be terminated before the end of September 1948, and the results will be presented to the secretariats of the United Nations Organisation and of its Educational, Scientific and Cultural Organisation as well as to the International Scientific Unions. It appears from the memorandum that the Committee contemplates investigations into these problems with the help of psychology, the social sciences, economics and juridical science as well as of the medical, agricultural and engineering sciences. In particular, the Committee urges the United Nations Educational, Scientific and Cultural Organisation to promote the formation of international organisations epresenting the medical and the engineering sciences. It is true that the composition of the Committee on Science and its Social Relations gives it little authority to speak for the engineering and medical sciences: ven for the physical sciences its basis may well be regarded as altogether too narrow to be representative. If that limitation is kept in mind, the proceedings at its meeting last June demonstrate that the Committee should nevertheless prove of real value in indicating gaps in the field which need attention, and in stimulating thought about general and particular problems.

In both respects it can be claimed that the present memorandum merits careful consideration by the world of science, and as Dr. Lampitt recently remarked in Edinburgh, at the annual meeting of the Society of Chemical Industry, too little is known, in Great Britain even, of the work of the international unions. Besides its observations on the danger to science inherent in subvention from military science, the Committee elaborated the principles of a Charter for Scientists which deserve full discussion, and in particular from the point of view of their practicability in industrial as well as in Government employment. It also focuses attention on two other principal aspects of the social relations of science: the changes introduced in human societies through technological developments of science; and the antagonisms between biological order and social order.

In regard to the first of these, the Committee suggests for investigation as soon as possible, in addition to subjects already proposed by the secretariats of the Natural Sciences Section of the United Nations Educational, Scientific and Cultural Organisation, the effect on society of such developments as vitamins, new races of wheat and other food grains, artificial insemination, television, products derived from nylon, antibiotics, sulphonamides, etc., and the medical applications of artificial radioactive elements. As a first step, it is proposed to create two subcommittees to consider the formation of study groups to investigate the various items, and another subcommittee will be formed to organise meetings of specialists where the points of view of the biologist, the sociologist and the psychologist can be brought to bear on the explanation of antagonisms between human biology and society.

The Committee on Science and its Social Relations may thus be making a much more vital contribution to the development of international understanding than the Atomic Scientists Association or like bodies are able to do at the present time. It is, of course, important that there should be no duplication of effort, and that the limitations of what is practicable at the present time should be kept in mind. Fortunately, the memorandum from the Committee on Science and its Social Relations indicates that the Committee is anxious to work harmoniously with the International Council of Scientific Unions and the United Nations Educational, Scientific and Cultural Organisation, and that it only proposes independent action where gaps are clearly seen to exist, and then by agreement as to the means to be used. There can, therefore, only be welcome for this further declaration as to the dependence of scientific advance on full freedom of communication and discussion, and for the proposals to foster fresh opportunities for contact between creative minds at those borderlands of the sciences which have in the past proved so often their fertilizing and stimulating power in intellectual effort.

LAWS AND CONSTITUTIONS

The Federalist, or the New Constitution

By Alexander Hamilton, James Madison and John Jay. Pp. lxxi + 484. (Oxford: Basil Blackwell, 1948.) 9*s.* 6*d.* net.

A Fragment on Government and An Introduction to the Principles of Morals and Legislation

By Jeremy Bentham. Pp. lxvii + 435. (Oxford: Basil Blackwell, 1948.) 9*s.* 6*d.* net.

IN an interesting comment on "The Federalist", immediately after the publication in 1788 of the last of the essays of which it is composed, Washington wrote to Hamilton: "When the transient circumstances and fugitive performances which attended this crisis shall have disappeared, that work will merit the notice of posterity, because in it are candidly discussed the principles of freedom and the topics of government, which will always be interesting to mankind, so long as they shall be connected in civil society". With the rapid increase of American power in the past half-century, and the significant emphasis placed upon the 'American way of life' in current political agitations, it is important that some effort should be made to understand the influences that have shaped the growth of the great Republic, and "The Federalist" must always stand as a revealing commentary on the struggles of its early days. Here it is presented in the simple but attractive format of Blackwell's "Political Texts" series, with a valuable introduction by Max Beloff.

The work is essentially a practical contribution to the controversies that raged about the constitution of the new United States during 1787–88; but at the same time, as Washington's comment suggests, it is concerned with some of the fundamental problems of politics. While seeking to justify the constitution, it also provided, by inference, a cautious analysis of society and of society's instrument, the State. But the analysis of society is based upon a belief in natural rights that was characteristic of the age and that had already found expression in the challenging words of the Declaration of Independence. Government and law, it was held, had the limited task of preserving natural rights, and especially the rights of property: "As long as the reason of man continues fallible . . . different opinions will be formed. . . . The diversity in the faculties of men, from which the rights of property originate, is not less an insuperable obstacle to an uniformity of interests. The protection of those faculties is the first object of government. From the protection of different and unequal faculties of acquiring property, the possession of different degrees and kinds of property immediately results; and from the influence of these on the sentiments and views of the respective proprietors, ensues a division of the society into different interests and parties. . . . A landed interest, a manufacturing interest, a mercantile interest, a moneyed interest . . . grow up of necessity in civilized nations. . . . The regulation of these various and interfering interests forms the principal task of modern legislation."

It would be unwise to read into this more than it was meant to convey; but here, as elsewhere in "The Federalist", are to be found the origins of the differences over the interpretation of 'democracy' that to-day divide east and west. Many of the ideas of the work look back to Locke a century earlier; but the framers of the American constitution were able to go far beyond Locke in basing their new system on a fundamental, written constitution. To this fact is to be attributed much of the static quality and legalistic character of the constitutional development of the United States, modified though this has been, from Jefferson to Roosevelt, by new glosses. In short, "The Federalist" is a valuable contribution to the study of contemporary history. The philosopher may condemn its limitations; but it has been described as "the finest study in the economic interpretation of politics which exists in any language", and, as Mr. Beloff rightly points out, "a text which can still be argued about, is a text worth reading". It has, moreover, acquired a new significance through the present discussions on "Western Union".

The American Declaration of Independence was issued in 1776, a year which proved to be something of an *annus mirabilis*, for it saw also the appearance of two other works of lasting influence, namely, Adam Smith's "Wealth of Nations" and Bentham's "Fragment on Government", which was itself a commentary on yet another book of importance in the political evolution of Britain and America, Blackstone's "Commentaries on the Laws of England" (1765). In the same year, too, Bentham was working on an introduction to a new penal code, which finally appeared in 1789 as "An Introduction to the Principles of Morals and Legislation". The "Fragment" and "Principles", Bentham's earliest works, now appear together in a convenient volume, introduced in a clear and balanced survey by Mr. Wilfrid Harrison. The two works, Mr. Harrison claims, "occupy a special place in political theory. They are the first major works in which a clear statement is given of the nature of government as an instrument the value of which is to be judged by its effects, and in which at the same time far-reaching claims are made in regard to the potential effectiveness of government." Earlier philosophers who had written of the State as a human rather than a divine institution had concerned themselves far more with the contractual obligations underlying it than with its actual working. Bentham, like the authors of "The Federalist", turned to practical issues, and sought by a critical examination of the conduct of man in society to suggest the lines of improvement. His own copy of the "Fragment", as Mr. Harrison reminds us, was inscribed by him: "This was the very first publication by which men at large were invited to break loose from the trammels of authority and ancestor-worship on the field of law"; while the very opening of the work links investigation ("discovery") with "reformation".

Bentham was thus typical of the best that his age could produce, though his influence was not widely felt until the great period of reform that opened in the eighteen-twenties, towards the end of his long life. Whether, but for the French Revolution and the horror of change that it excited, he could have achieved more at an earlier period cannot now be decided; but the influence of this typically eighteenth-century thinker of the pre-industrial era is writ large upon the history of Britain and British ideas in the nineteenth century. That influence flowed largely from Bentham, the philosophical radical of the later period. The interest of these earlier works lies partly in the optimistic view of human nature which led him later to declare of the period in which they were written that he "never suspected that the people in power were against reform; [he] supposed they only wanted to know what was good in order to embrace it". Utilitarianism is now a largely discredited creed; but its place in nineteenth century developments cannot be ignored. Bentham's work, vast in quantity, was fragmentary and limited in scope; but his method of critical thinking, as set out, for example, in the closing words of the "Fragment", was sound, and with "The Federalist" in mind one may read with interest its application in the "Principles" to the ideas of the Declaration of Independence. "With men, who are unanimous and hearty about *measures*", Bentham wrote, "nothing is so weak but may pass in the character of a *reason*." The remark, and the method, have lost none of their validity during the period of nearly two centuries since these words were set down. MAURICE BRUCE

BERKELEY: FATHER OF PLANT PATHOLOGY

Phytopathological Classics, No. 8

Observations, Botanical and Physiological, on the Potato Murrain. By M. J. Berkeley; together with Selections from Berkeley's "Vegetable Pathology" made by the Plant Pathology Committee of the British Mycological Society. Pp. 108. (East Lansing, Mich.: American Phytopathological Society, 1948.) 1.50 dollars.

MODERN farmers and gardeners are now well acquainted with the possibilities of control of plant disease. Should a new trouble be found, it is usually only a matter of time before a palliative or remedy is discovered. It is, therefore, somewhat difficult for us to realize the state of passive acceptance of crop 'blights' which prevailed a century ago. We can, however, give a far greater measure of appreciation than could be accorded by his contemporaries to the Rev. Miles Joseph Berkeley. He, more than any other, established on a sure foundation the conception of plant disease caused by parasitic fungi.

It is true that fungi had been found growing on plants to their detriment before Berkeley's classic paper on the 'potato murrain' appeared. There was, however, no clear indication whether they were the primary cause, or a secondary effect, of the diseased condition. Berkeley's full powers were called forth by his celebrated literary controversy with Dr. John Lindley, who stated the purely physiological view that the 'murrain' was due to disturbed water relations resulting from unusual climatic conditions. It is impossible not to feel reverence for the scholarship and erudition of Berkeley's paper. Now that it is reprinted in this classic form, it can provide background for teacher and student, and still give inspiration to the more specialized mycologist.

The selections from "Vegetable Pathology" made by the Plant Pathology Committee of the British Mycological Society provoke rather a different note of humility. The completeness of Berkeley's conception of disease as abnormal functioning of plants finds, as yet, no corresponding completeness in modern studies. We are, alas, only too well acquainted with 'Congelatio, freezing' and 'Sphrigosis, rankness', but know all too little about them. Should anyone ask us the cause of 'Exostosis, hard excrescences consisting of sound tissue', we can only say we know they occur, and shake our heads about the cause. It is not that we have been idle, for studies on virus, on mineral deficiencies and on some non-parasitic maladies have explained many of Berkeley's classified diseases. The science of genetics has elucidated still more. The real shortcoming is that whereas Berkeley directed the attention of mankind to damage caused by parasitic fungi, and showed that it was amenable to control—he it was who suggested the use of sulphur and lime to Mr. Tucker—the science of plant pathology languished until twenty years ago. It then began to gather momentum, is now beginning to command the respect of practical growers, and should look forward to a brighter future. JOHN GRAINGER

FROM RADIUM TO THE ATOMIC BOMB

Atomic Energy

By Dr. R. R. Nimmo. (Frontiers of Science Series.) Pp. 201. (London: Pilot Press, Ltd., 1947.) 9*s*. 6*d*.

THE 'Frontiers of Science' series, of which this is the first number, is stated to be "intended for the growing non-specialist public which wants to keep abreast of recent scientific developments and so keep pace with a changing world". Atomic energy is undoubtedly one such important scientific development, and the general editor of the series, Dr. A. C. B. Lovell, has chosen well in asking Dr. Nimmo to write an account of the progress made in nuclear physics from the discovery of radioactivity in 1896 to the release of the first atomic bomb in 1945. Dr. Nimmo was, during the Second World War, a member of the British team engaged on the atomic bomb project in the United States, and has since been working at the University of Birmingham on the construction of particle accelerators, so that he writes on his subject with considerable authority and knowledge. It is true that Dr. Nimmo divulges no secrets, nor gives any information that is not contained in the official Smyth Report; but he does not hesitate to read between the lines and to set down in detail all reasonable deductions that an expert in this field can make from the official information.

To those with a moderate knowledge of chemistry and physics the first half of the book can be recommended as an excellent introduction to modern atomic structure and as an account of modern experimental techniques. The second half of the book deals with nuclear fission, chain reactions, uranium piles, plutonium, the atomic bomb and atomic energy plants, and will be read with interest by all who have not access to, nor the time nor ability to wade through, the mass of uncorrelated information which has been published during the last few years.

The last chapter of the book, on atomic energy and the future, is naturally speculative, but the problems to be faced and overcome are clearly stated, and the difficulties in the way of rapid development of nuclear physics, such as considerations of military security and the delay in the declassification of fundamental data, are specifically mentioned. The author's attitude is well summed-up in the concluding sentence of the book, "The future is full of hope and promise, but only if we see to it that never again are these new powers used for killing and destruction".

The reviewer has two faults to find with this otherwise excellent book. One is that, though reference is made to the health hazards in atomic energy work, little or no reference is made to the great benefits of the use of radioactive tracers in medicine, agriculture and industry. The other is the unusual arrangement of type and size of page, which, with its long close lines, is very fatiguing to the reader. S. WEINTROUB

UNIVERSITY EDUCATION IN NOTTINGHAM

By Prof. H. T. H. PIAGGIO

On July 9, 1948, the King in Council conferred full university status upon University College, Nottingham, so that the efforts of more than seventy years were crowned with success. In 1875 Mr. Richard Enfield asked the Nottingham Corporation to erect buildings to accommodate the Cambridge University extension lectures then being delivered in the city, and to add a library and a chemical laboratory. An anonymous donor offered £10,000 for this purpose. The Corporation adopted the scheme in an improved form, to include also a natural history museum and provision for the teaching of several branches of science, which up to then had been carried on by the Mechanics' Institute. The foundation stone was laid in 1877, and the College opened in 1881. At first there were only four professors, the Rev. J. F. Blake (natural sciences), Dr. F. Clowes (chemistry and metallurgy), Dr. J. A. Fleming (physics, mathematics and mechanics), and the Rev. J. E. Symes (English), with four lecturers, two demonstrators, and fifteen part-time teachers of science. Dr. Fleming (later Sir Ambrose Fleming, the inventor of the thermionic valve) left after one year, and was succeeded by Mr. William Garnett. At first there was no principal; but Dr. Clowes acted in this capacity from 1887 until 1890, and Mr. Symes from 1890 until 1911, both in addition to their professorial duties. A professor of engineering was appointed in 1884. In the following year the College started to train teachers. In 1893 a new wing was opened for the engineering and technical students, designed by the versatile Dr. Frank Granger, who later became professor of classics and philosophy. In 1898, Mr. Ernest Weekley, afterwards well known for his books on philology, became professor of French, and Dr. F. S. Kipping, from whose researches on the organic compounds of silicon the new silicone plastic industry has developed, became professor of chemistry. The culmination of this period of development was the Charter of Incorporation (as a University College) conferred by the Privy Council in 1903.

After this, for some reason, there was a check to the development. Perhaps the splendid initiative of the Nottingham Corporation in founding the College led the citizens to think that there was no need for them to take an active interest. Certainly the neighbouring counties considered it purely a Nottingham affair, which was no responsibility of theirs. In 1911 it became evident to Mr. W. H. Heaton, who after many years as professor of physics and mathematics had been appointed principal, that if a great effort was not made, the College was likely to decline. He established professorships of mining, economics and commerce, geology and geography, and history, and in 1913 there were hopes of a full charter. But in 1914 came war, and for four years the College was nearly empty. In 1919 the ex-Service men returned in embarrassing numbers, and the buildings were greatly overcrowded. The site in Shakespeare Street had very little room for expansion. There was difficulty in obtaining staff, and the financial position gave cause for anxiety. At a time when the difficulties seemed almost insuperable, Alderman E. Huntsman directed the attention of Sir Jesse Boot (afterwards Lord Trent) to the good work done by the College; thus, for example, an evening student, Mr. E. H. Barton, was able to become a professor of physics, a fellow of the Royal Society, and a recognized authority on acoustics. Sir Jesse's interest was aroused, and he allocated to the College a large site with a setting of exceptional beauty above the lake in University Park. Since then the College Council has acquired a good deal of adjacent land, and is now in the happy position of having room for as many lecture rooms, laboratories, and halls of residence as are likely to be required for very many years to come. The new buildings were opened by King George V in 1928; but for some years longer the Faculty of Applied Science remained in Shakespeare Street, Nottingham, which also remained the headquarters of the vigorous Adult Education Department set up in 1920 under Mr. (later Prof.) Robert Peers. This Department is one of the largest of its kind in Great Britain.

In 1930 Mr. Hugh Stewart became principal, and threw himself with great energy into preparing for full university status. In particular he emphasized the importance of research. He pointed out the necessity of transforming the governing body to take account of the fact that the College now served the whole of the East Midlands. Unfortunately, his incessant labours caused his untimely death in 1934. After a year with Dr. Granger as acting-principal, Mr. H. A. S. Wortley was appointed principal. He had gained an extensive knowledge of the needs of the area in his former capacity as professor of education, and his wide popularity enabled him to carry through changes which, though necessary, were sometimes a break with local traditions. In 1938 he obtained the supplementary charter, which reconstituted the governing body on the lines suggested by Principal Stewart. From 1939 until 1945 progress was again stopped by war. In 1945 the University College handed over the Shakespeare Street buildings and the responsibility for evening classes and technical education to a new authority, the Nottingham and District Technical College. In 1947 the Midland Agricultural College became part of the University College. In the same year was set up an Institute of Education, which will co-ordinate educational activities, including research, over a wide area.

It was anticipated that Principal Wortley's next achievement would be the attainment of a full charter; but worn out with the double burden of the war years, during which he also acted as deputy regional commissioner, his health collapsed, and he died suddenly in 1947. The arduous task of gathering up, at short notice, the many tangled threads of half-completed schemes was taken up by Prof. Peers, who, as acting-principal, had the satisfaction of reaching the goal towards which so many had striven for so long. He has also greatly strengthened the staff, made fuller provision for research, and drawn up the degree regulations for the new university. Mr. B. L. Hallward, for many years fellow of Peterhouse, Cambridge, and at present headmaster of Clifton College, will become the first vice-chancellor. The chancellor is Lord Trent, previously president and chairman of the College Council. He is the son of the College's great benefactor.

The University will start with five faculties, arts (including law, theology, music, economics and social administration), education, pure science (including pharmacy), applied science (mechanical, electrical and civil engineering, mining and fuels) and agriculture (including horticulture). New professorships are being established, and new buildings erected. The number of students is now about three times that in 1938–39, and applicants have to be refused for lack of room. Negotiations to consider how the University and the technical colleges of the area can co-operate are in progress.

In addition to all the usual academic subjects (except medicine), the University will deal with certain special branches in which it feels particularly strong. It will continue the biochemical studies of the late Prof. J. M. Gulland, but with a shift of emphasis from nucleic acids to heterocyclic organic compounds of importance in chemotherapy. Pharmacy will continue to receive much attention, and will develop on the research side. Among other strong points are magnetism, mycology (with a graduate diploma), ecology and parasitology of freshwater fishes, soil mechanics, statistical methods, town planning, and Biblical and related studies. The East Midlands is an important mining area, and the University is dealing with the related geological problems, and with mine ventilation. Experiments in new methods of mine illumination are expected to contribute to the health and amenities of the workers at the coal face.

A Board of Local Studies has been set up. Contributions have already been made to Roman-British archæology, the history of the Civil War (which started in Nottingham) and of other national events with a local setting, also of economic conditions in the eighteenth and nineteenth century, particularly of the lace and hosiery trade. A valuable source of information about medieval social and economic conditions is now available in the University library, in which Lord Middleton and Mrs. Percy Clifton, representing two families which go back for many centuries, have deposited their family records. Economic conditions of our own time will be studied by the rapidly increasing Department of Economics and Social Study, which is now to be subdivided. We look forward with confidence to the contribution the University will make to the East Midlands, to the nation, and to the international fraternity of learning.

ENZYMATIC CONTROL OF CELL DIVISION IN MICRO-ORGANISMS*

By Dr. WALTER J. NICKERSON
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FROM lines of evidence converging from apparently widely separated fields it now appears possible to assemble evidence indicating that cell division in micro-organisms, and probably also in other organisms, is under the control of a unit enzymatic mechanism. The lines of investigation, developed quite independently, forming the foundations for this thesis are: (1) physico-chemical studies by Hinshelwood and co-workers[1] on the kinetics of bacterial growth and the state of balance between division and elongation; (2) the studies of Witkin[2] (genetic), Eisenstark and Clark[3] (electron microscope), and others[20,21,22] on irradiated bacteria; (3) cytochemical investigations of Pratt and Dufrenoy[4] on the mode of action of penicillin; (4) metabolic studies on dimorphic pathogenic fungi by Nickerson and Edwards[5]; and (5) examination of the chemical control of morphogenesis in yeasts by Jillson and Nickerson[6], the common denominator in all of these lines of investigation being a close examination of the effects of inimical or critical conditions on the morphogenesis of dividing cells. The examinations have revealed a common fundamental attribute of cell division of micro-organisms.

This fundamental attribute may be expressed by the use of a simple notation. Bacteria (B) may be induced to elongate into filaments (F) by various treatments which inhibit cell division but which do not simultaneously inhibit growth. The process itself may be denoted as a $B \rightarrow F$ conversion. Likewise with yeasts (Y), it is possible both to induce elongation into mycelia (M) structures through inhibition of cell division, and to inhibit the process in yeasts that normally show $Y \rightarrow M$ conversions as a characteristic feature. There are, furthermore, fungi which can be interconverted from a mycelial to a yeast form by changes in temperature alone, and for these it seems permissible to write $Y \rightleftharpoons M$ as an expression of the phenomenon. In the three cases the normal division mechanism by which micro-organisms maintain a single-cell condition may be inhibited without the simultaneous inhibition of other metabolic processes, thus permitting the organism to grow, unchecked, as a filament. Other common properties of the $B \rightarrow F$ and $Y \rightarrow M$ processes, as will be shown, permit the assumption that a comparable mechanism is being affected in the three cases.

Hinshelwood has developed a very convenient concept with respect to the change $B \rightarrow F$ from his studies on the action of proflavine, *m*-cresol, and of the effect of the nitrogen source on bacterial growth. Normal growth is viewed as the result of a balance between a division (D) factor and an elongation (L) factor; the latter factor has been shown to be diffusible. This diffusibility of the elongation factor L was recorded from the property of culture filtrates from *Bact. lactis aerogenes* of hastening the onset of growth, through a shortening of the lag period, when added to culture media; in some instances division did not keep pace, and the process $B \rightarrow F$ resulted. Other methods for disturbing the balance between the division and elongation factors included the incorporation into a nutrient medium of traces of *m*-cresol or proflavine; these agents selectively inhibited division without exerting marked suppressive action on other cell functions, with the result that cultures of *Bact. lactis aerogenes* so treated consisted of tangled masses of long thread-like elements.

While the appearance of the $B \rightarrow F$ phenomena is not markedly apparent with most bacteria in ordinary culture media, the production of the $Y \rightarrow M$ process and the occurrence of $Y \rightleftharpoons M$ among several of the pathogenic fungi are essential characteristics of their identification. It will be well to present at once the reasons for believing that the growth of yeasts by budding and of bacteria by fission may be accomplished in a comparable fashion despite apparent morphological differences between the two modes of growth. At least three rather convincing reasons may be advanced for this view. (1) Budding of yeasts has been shown[37] to exhibit the same mechanical principle (Principle of Least Action) characterizing the growth of other cells with determinate axes (*inter alia*, rod-shaped bacteria), for a yeast bud arises so that its long axis is a tangent to the mother cell at the point of contact. (2) There are genera of yeasts, for example, *Saccaromycodes*, which reproduce by fission, as do bacteria, but which are ostensibly related to other yeasts. (3) As will be shown, certain substances in trace concentrations promote the process $B \rightarrow F$ (and, furthermore, the promotion of $B \rightarrow F$ in Gram-positive bacteria is accompanied by a loss of Gram-positivity); these same substances, in trace concentrations, promote the process $Y \rightarrow M$ and loss of Gram-positivity in yeasts. Having set forth seemingly valid reasons for believing that the division of yeasts and of bacteria result from the action of closely comparable mechanisms, we may proceed with further comparisons.

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Among the yeasts, the order Mycotoruloideæ is characterized by the formation of mycelial structures; three genera, *Candida*, *Trichosporon* and *Brettanomyces*, are included in the group. Experimental work pertinent to the discussion has been carried out mainly with species of *Candida*. In this genus there is one species, *C. albicans*, undoubtedly pathogenic for man and experimental animals, together with species of probable pathogenicity, and others that are non-pathogenic. All species exhibit the process $Y \rightarrow M$ under appropriate conditions. *C. albicans* may cause infections of various tissues, including chronic infections of the skin and nails. These latter regions may also be infected by other pathogenic fungi, the dermatophytes; now it is a clinical fact that mixed fungus infections of the skin or nails are rarely encountered. With isolates of *C. albicans* and the dermatophyte, *Trichophyton rubrum*, obtained from nail infections, Jillson and Nickerson[6] attempted to learn if the growth of one fungus could inhibit the growth of the other in culture and thus contribute an explanation for the known clinical situation. Such was, indeed, found to be probable. But the inhibitory effect exerted on *C. albicans* by *T. rubrum* was of a differential type; only the development of mycelial structure, M, was inhibited, whereas growth in the yeast phase, Y, was not appreciably affected. This *T. rubrum* effect was obtained first in two-membered pure cultures, and later shown to result from the production of two diffusible metabolic products, which have been partially characterized. Recently it has been found that activity in one of the fractions is probably the result of its —SH group content.

Early in the study of the effects of penicillin action on micro-organisms, it was found by Gardner[7] that sub-bacteriostatic concentrations of penicillin induced $B \rightarrow F$ conversions in Gram-negative as well as in Gram-positive bacteria. More recently, the cytochemical investigations of Pratt and Dufrenoy[4] have amply confirmed this point and demonstrated that Gram-positive bacteria become Gram-negative in the process. The latter authors have also made it clear that the probable mode of action of penicillin against Gram-negative organisms is the same as against Gram-positive organisms, in spite of the higher concentrations needed to achieve effects against the Gram-negative group. A very significant point emerging from these researches[4] is the implication of —SH group oxidation with the mode of action of penicillin. In plate inhibition-zone studies with *Staphylococcus aureus*, positive tests for —SH groups were always obtained with cells in the uninhibited regions, but were never obtained in the inhibited zone. The fact that loss of stainability of the Gram-positive complex accompanied the $B \rightarrow F$ process, resulting from penicillin action, also implicates —SH group oxidation, since Henry and Stacey's[8] investigations on the chemical nature of the Gram-positive complex have shown it to be magnesium ribonucleate with associated –SH groups; oxidation to S—S abolished the stainability of the complex. Pratt and Dufrenoy have expressed the view[4] that penicillin exerts its bacteriostatic effect by promoting the oxidation of —SH to S—S, and Cavallito[9] has shown that cysteine can suppress the action of penicillin, presumably by acting as an —SH donor.

The probability that —SH groups represent the active component of one of the *T. rubrum* filtrate factors effecting a suppression of the $Y \rightarrow M$ process may be taken as further evidence of the similarity of cell division processes in bacteria and in yeasts. Similarity in the action of cobalt on penicillin inhibition and on the $Y \rightarrow M$ process further links —SH groups in the two processes. Pratt and Dufrenoy[4] have noted that trace amounts of the cobalt ion Co^{++} increase the sensitivity of micro-organisms to penicillin inhibition. It seems possible that the effect of cobalt lies in its ability to form complexes with cysteine, as shown by the work of Michaelis[10]. In studies on the toxicity of cobalt to yeasts[11], a very sharp break appeared in the curve of growth *v.* concentration of cobalt ion in the region of $M/10{,}000\ Co^{++}$. Employing radioactive $Co^{56}+{}^{58}$, it was found[11] that most of the activity accumulated in growing yeast cells in one distinct fraction. The activity was retained in the cells during prolonged washing and during ether-acetone extraction, but was removed by cold 10 per cent trichloracetic acid extraction. The $Co^{56}+{}^{58}$ was precipitable from this extract on standing, after neutralization, as a light, brownish flocculant. Work on the type of binding for the cobalt in this fraction is in progress. The addition of Co^{++} to media, in amounts insufficient to inhibit growth, favours the development of $Y \rightarrow M$ process in yeasts ordinarily existing only in a Y form on agar media. *Hansenula anomala* has been particularly examined in this connexion[12,13]. It develops much elongated cells, which tend to remain attached to give an appearance suggesting 'trees', on a malt agar medium with added cobalt ions. Cysteine antagonizes the cobalt ion effect.

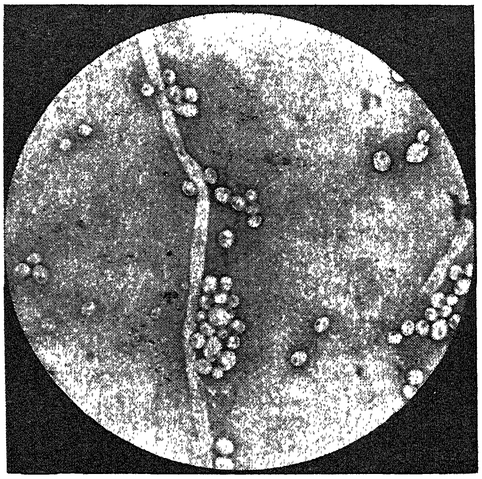

Fig. 1. *Candida albicans* from untreated slide culture on potato agar showing normal production of Y- and M-forms. Stained with 1 per cent aqueous toluidine blue; distinct nucleus in each Y-cell; three nuclei may be discerned along the length of the M filament. × 750

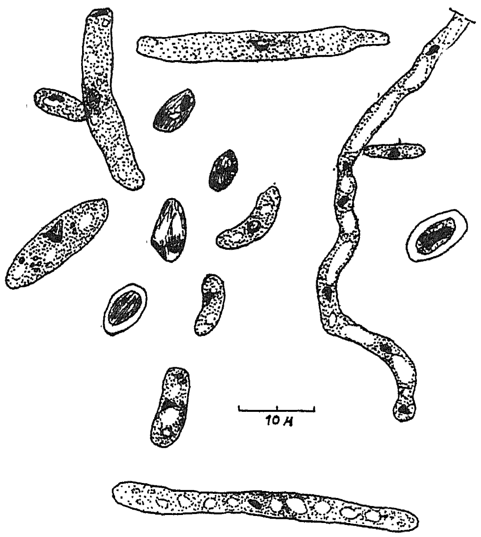

Fig. 2. *Trichosporon capitatum* from potato agar slide culture with penicillin (10 O.U./ml.). Toluidine blue staining. Production of two types of Y-cells (arthrospores and blastospores) is characteristic of this yeast. Nuclei were spaced at more or less regular intervals for more than 100 μ along the partially drawn M-filament

The implication of the —SH group of cysteine in the division processes of bacteria and of yeasts recalls the earlier work of Voegtlin and Chalkley[14] on *Amœba proteus*, of Hammett[15] on *Paramecium*, and of Brachet[16] on the embryonic development of Amphibia. In all this work, a relationship between —SH groups and cell division was strongly indicated. With *Amœba* it appeared[14] that glutathione enhanced the rate of nuclear growth (while cupric ions impeded it), thus speeding cell division, since division occurred regularly at an almost constant nuclear volume. In the experiments of Chalkley and Daniel[17] on *Amœba*, it was found that on the failure of fission processes (experimentally induced) to result in cell division, there remained no 'residual tendency' towards division; the cell was left with two nuclei. Division of one of these was necessary before cell division would again occur. In a general way, this relationship holds with yeasts for $Y \rightarrow M$ processes. Extremely long filaments may be observed with only one or a few nuclei scattered along the length of the M growth. With *Candida albicans*, which produces clusters of blastospores (uninucleate Y cells) at loci spaced along an M axis (see Fig. 1), we may have an example wherein division of an M-nucleus results, not in division of the already formed filament, but in intensive localized budding of yeast cells. In other instances (Fig. 2) M-elements may be seen with numerous nuclei scattered along the filament. In the $Y \rightarrow M$ process it appears that the normal close association between nuclear and cell division is disrupted so that growth occurs without cell division, while nuclear division may or may not occur.

In the experiments of Hinshelwood on bacteria and of Nickerson *et al.* on yeasts, a very large proportion of the cells exposed to the various division-inhibiting substances were found to have entered an elongated state. Normally, with *C. albicans*, one may observe mycelia production around the entire border of a colony. The very high proportion of cells exhibiting an inhibited division, but uninhibited growth (defined as an irreversible increase in volume, following Went and Thimann[18]), seems to preclude the operation of mutational or survival-selection mechanisms as the basis for the observed phenomena. This is strengthened by the reversible nature of the processes, since filament or mycelial stages may readily give rise to bacterial or yeast forms of growth following the removal of the active chemical agents and transfer to suitable growth media. It seems permissible to regard the inhibition of division as the inhibition of an enzymatic mechanism, which may resume functioning when the inhibiting agents are removed. The effectiveness of proflavine, *m*-cresol, cysteine, and cobalt in trace concentrations against the division mechanism of growing cells favours an enzyme-inhibition concept. The specificity of these substances for the division mechanism of growing cells favours a unit enzyme-inhibition concept.

The argument in favour of a unit enzymatic division mechanism in cells of micro-organisms based on the specific response of cells to trace concentrations of proflavine, *m*-cresol, cobalt, and cysteine may be even more forcefully presented in the case of penicillin. Penicillin, as Dubos[19] has emphasized, does not act as a generalized, non-specific protoplasmic poison; its effectiveness in high dilution favours the concept of attack on specific loci of the cell. Much evidence now points to the action of sodium-penicillin G as operating through a shift toward the right in the —SH ⇌ S—S functions of the cells; as has been noted, cysteine (—SH) suppresses the action of penicillin. The action of penicillin *in sub-bacteriostatic concentrations* in promoting the process $B \rightarrow F$ is one of the first detectable effects of penicillin. This specificity at extreme dilution is significant. The parallel (see Table) between the general phenomena of the processes of filament formation in bacteria, mycelium formation in yeasts, and penicillin action indicates a common specific functional unit as the sensitive locus in the cell.

Such a unitary enzyme concept is supported by genetic studies on irradiated bacteria (Witkin[2], Lea[20]), and by electron microscope studies of irradiated bacteria (Eisenstark and Clark[3]). Following ionizing radiation of bacterial cultures, Kempster[21] early observed that cells might fail to divide but retained the power of growth since elongated filaments were produced. Haberman and Ellsworth[22] have produced elongated cocci by such procedures, and Witkin[2] obtained greatly elongated cells of *Esch. coli*. The elongations following radiation have generally been observed to be irreversible.

Witkin, employing X-radiation, has obtained permanent $B \rightarrow F$ conversions; her analysis of the dosage-response data indicates a 'one hit–one gene' inactivation. Examination of filaments of *Esch. coli* (X-ray induced) in the electron microscope by

Agents uncoupling cell-division from cell-growth

Compound	$B \rightarrow F$	$Y \rightarrow M$	Gram positivity	Ribonuclease action
Proflavine	promoted[1]	promoted[13]	abolished[13,32]	inhibited[29]
Cobalt	promoted[4,12]	promoted[12]	abolished[12]	
Cysteine	prevented[4,12]	prevented[12]	preserved[12]	
Penicillin	promoted[4,7]	promoted[12]	abolished[4]	inhibited[33]

Eisenstark and Clark revealed 'breaks' spaced periodically along the length of a filament; they put forward the hypothesis that an "enzyme responsible for pinching off the cell wall in normal bacterial fission has been destroyed by rays while other enzyme systems continue to function".

With the group of pathogenic fungi exhibiting the process $M \rightleftharpoons Y$, depending on the temperature of incubation, it has recently been shown by Levine and Ordal[23] and by Nickerson and Edwards[5] that the interconversion of form is solely a function of temperature. The $M \rightleftharpoons Y$ transformations in *Blastomyces dermatitidis* and *B. brasiliensis* are obtainable without difficulty on a simple nutrient medium (consisting of ammonium-nitrogen, inorganic salts and glucose) just as they are obtained on complex media. No growth-factor requirements have been observed for either species of *Blastomyces*, nor have special atmospheric requirements been found to be necessary for the process $M \rightleftharpoons Y$. Since no chemical agent need be added to the cultures to promote the morphogenetic transformations, it seems that effects of temperature on the metabolism of these organisms may be examined more closely for possible clues to its action in the regulation of morphogenesis.

Oxygen consumption seemed particularly important in this regard; respiratory measurements were made on washed, vigorous mycelia over a range of temperature in an ultra-micro respirometer. With intervals of 3–5° over a range from 3–45°, it appeared that plots of rate *v.* temperature in degrees lent themselves to a separation of two ranges, 3–20° and 20–40°. However, plots of rate *v.* the reciprocal of absolute temperature gave curves which were slightly concave downwards; no 'breaks' or 'critical points' were noticeable. These data fit well with the recent mathematical formalization for temperature increments in biological processes elaborated by Morales[24] on the basis of the Johnson–Eyring formulation[25] of absolute reaction-rates. In this interpretation, two rate-limiting processes control the observed reaction-rates; at lower temperatures (3–20°) the splitting of substrate-enzyme complexes is rate-limiting, while in the higher range (20–40°) reversible enzymic denaturation becomes rate-limiting. Such a formulation does not imply 'breaks' in the plots of rate *v.* the reciprocal of absolute temperature. Rather, it leads to curves that are smoothly concave downwards.

No clues of the physiological mechanism underlying the *thermal dimorphism* of *Blastomyces* were obtained from these experiments on the effect of small temperature changes on oxygen consumption. When similar measurements were made on mycelial preparations exposed to large changes in temperature (15° or more) there appeared what is commonly termed 'overshoot', or exaggerated response, phenomena. (It should be pointed out that the process $M \rightarrow Y$ is obtained with these organisms following the transfer of a mycelial culture from room temperature to the 37° C. incubator—a jump of more than 15° C.) Following an abrupt increase from 5 to 20°, the rate of oxygen consumption was briefly higher than expected for the 20°-level, following which it rapidly recovered to the normal rate for the indicated temperature. (The brief higher level is not an artefact of technique.) An increase from 20° to 40° resulted in a tremendously increased rate of oxygen consumption that slowly levelled off to the rate anticipated for 40° C. If we view the rate of oxygen consumption as normally being determined in the range 5–20° by a constant k_1, which is a measure of the rate of enzyme substrate splitting and, in the range 20–40°, as the result of two simultaneous rate-limiting phenomena k_1 and k_2 (the constant for a reversible enzyme denaturation), we may write the following expression:

$$5^\circ \xrightarrow{k_1} 20^\circ \overset{k_1}{\underset{k_2}{\rightleftharpoons}} 40^\circ$$

where the arrow to the right indicates increasing velocity of reaction and that to the left (←, denoting reversibility) indicates a decreasing effect on velocity. Since at any given temperature in the range 20–40° the rate of oxygen consumption is constant for many hours, we may conclude that k_1 and k_2 have achieved a steady state. The large, abrupt increases in temperature upset this steady state to produce a situation which may be expressed by:

$$\begin{array}{c}20^\circ\\ \overset{k_1}{\underset{k_2}{\rightleftharpoons}}\end{array} \xrightarrow[\text{change of } >15^\circ]{\text{abrupt}} \left[\xrightarrow[k_1]{40^\circ}\right] \xrightarrow{\text{time}} \begin{array}{c}40^\circ\\ \overset{k_1}{\underset{k_2}{\rightleftharpoons}}\end{array} \begin{array}{l}\text{(gradual}\\ \text{restoration)}\end{array}$$

The temporary apparent suppression of the rate-limiting factor k_2 is deduced from the overshoot in oxygen consumption. That this 'apparent suppression' probably results from measurable difference in the speeds with which the two rate-limiting processes return to equilibria is seen from the difference in times required for the reappearance of a steady state at 20° and at 40° after large jumps to these temperatures.

In view of the fact that the other aspects of the metabolism of *Blastomyces* investigated thus far, other than oxygen consumption, are comparable for the yeast and the mycelial forms, we are inclined to attach importance to the results for respiration, in the sense that they may indicate the physiological basis for the observed thermal dimorphism. We may conceive that the cell division enzyme complex (D) lies at the end of a chain of consecutive reactions which produce its substrate (s); it is further conceivable that (D) must compete for (s) with another enzyme complex (X) which is concerned with cell elongation.

$$\begin{tikzcd} & \text{division} \\ s \arrow[ur, "D"] \arrow[dr, "X"'] & \\ & \text{elongation} \end{tikzcd}$$

Let (s) be produced by reactions for which the rate-limiting processes are only of the enzyme-substrate splitting category, and assume that (X) has a higher affinity for (s) than has (D). Under such conditions, elongation will result and division will be suppressed. If, for the reaction $s \xrightarrow{X}$ elongation, the rate-limiting factor is the reversible denaturation of (X), it may be possible for the reaction $s \xrightarrow{D}$ division to predominate at higher temperatures. In view of the lag in 'adjustment' of the process in respiration which probably is rate-limiting by reason of its reversible denaturation, we might say that a parallel phenomenon, operating in a growth mechanism of the type conjectured, would result in a supply of (s) saturating (X), thus permitting an initiation of the (D) reaction.

The actual nature of D, X and s (and definitive evidence for their existence) must be left for future investigations. In view of Hinshelwood's implication of the importance of the source of nitrogen for the $B \rightarrow F$ process in *Bact. lactis aerogenes*, and earlier work of Langeron and Guerra[26] along similar lines for the $Y \rightarrow M$ process in *C. albicans*, we may see indications of the nature of (s). Viewing elongation as 'straight growth' and division as 'curved growth', it may reasonably be imagined that 'rigid' or 'flexible' molecules resulted respectively from the action of X or D. In this connexion the recent investigations of Jeener[27] and Lyons[34] on the fibrinogen-fibrin proteins are suggestive; the critical importance of $\text{—SH} \rightleftharpoons \text{—S—S—}$ in this process makes it even more suggestive, since —SH maintenance inhibited fibrin formation, and —SH donors maintain spherical growth of yeast cells. The analogy between maintenance of cell division and the prevention of disulphide-link formation in a fibrous protein may actually be far more than a superficial one. As Astbury[35] has so fascinatingly written, ". . . the molecular plan of the keratin–myosin–fibrinogen group is one of the great primal ideas in vital architecture. . . . It represents a fundamental power of the cell of synthesizing elastic fibrous protein of a standard molecular form, yet whose details can be adapted to a variety of ends as the processes of differentiation demand." The ability of a cell to grow may then reside in its ability to form elastic fibrous protein, and its ability to divide may reside in its potential to prevent the formation of intermolecular disulphide links and resultant loss of molecular elasticity. Such a concept of cell division is, in fact, reminiscent of that elaborated by Rapkine[36] several years ago, who held that cell division is accompanied by configurational rearrangements of cell protein resulting in an increase in the appearance of protein —SH groups.

In view of recent work[28] on the mechanism of action of acridines (proflavine, trypaflavine), we may consider some relationships of nucleic acid metabolism in $Y \rightarrow M$ phenomena. Acridines are believed to exert their growth- (and respiration-) inhibition effects by union with nucleoproteins of the cell[28]; this inhibition may be overcome by addition of nucleic acid[29,30]; nucleic acid-proflavine complexes have been prepared[30]. It is clear that the ribose nucleic acid content of cells that have undergone the $Y \rightarrow M$ process is greatly lowered; they are Gram-negative, and are stained scarcely at all by pyronin from the Pappenheim-Unna mixture. Yet these cells have grown and undoubtedly synthesized protein. Populations of elongated cells may be grown (excluding the possibility of 'redistribution' from the Y form) which are pyronin 'negative'[13]. Spiegelman and Kamen[31] have recently queried the correlation between nucleic acid metabolism and protein synthesis. Results from the study of the $Y \rightarrow M$ and $B \rightarrow F$ processes *appear* to augment their query. But if particular types of protein synthesis (and maintenance of elasticity) are involved in division processes, it may be that it is with these that nucleic acid metabolism is associated[16] during normal growth and cell division.

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PHYSICAL PROPERTIES OF SUBSTANCES OF HIGH PERMITTIVITY

On June 12, the Electronics Group of the Institute of Physics held a symposium on substances of high permittivity, the so-called ferro-electrics. Three papers were followed by a discussion. Original results were reported by speakers both in the last two papers and in the discussion—a sign of the considerable interest shown.

A survey of the electrical and crystallographic background of ferro-electricity was given by Dr. Vera Daniel (British Electrical Research Association). She pointed out that the essential feature of ferro-electric materials is that they consist of domains with a spontaneous electric polarization. With no external field and in equilibrium, the moments of these domains cancel each other. The effect of a field on a specimen of such a material is two-fold. It influences the polarization of each domain and it may also reverse the polarization of domains. The spontaneous polarization of an individual domain is an equilibrium property, and at any given temperature the differential of this polarization, with regard to field strength, defines an 'equilibrium' permittivity. The permittivity of a real specimen is made up of this equilibrium permittivity plus a contribution due to the reversal of domains. The latter contribution is necessarily very sensitive to structure and implies the existence of saturation effects; for if already all domains are aligned in the direction of the field, no further domains can be reversed. The reversal of domains also leads to hysteresis.

All ferro-electric materials are crystalline, and from the point of view of the crystallographer their properties imply unusual conditions. It is not rare for crystalline substances to have a spontaneous polarization; but in the majority of cases this does not depend appreciably on electric field strength, and domains cannot be reversed by a field. It is quite exceptional that the forces controlling the polarity are as weak as to be comparable with the energy of an applied field, which is the case for ferro-electrics. All known cases of ferro-electricity are connected with the change of a structure with spontaneous polarization into one without such polarization. These changes occur gradually over a temperature interval, the spontaneous polarization decreasing more and more rapidly on approaching a critical temperature, called the Curie point in analogy with ferro-magnetism. Thermodynamically, the change of structure may be a first- or second-order transition. The Curie point is associated with a sharp peak of the permittivity.

Dr. Daniel concluded by discussing experimental and theoretical work done on Rochelle salt, potassium dihydrogen phosphate and ferro-electrics of similar structures. Ferro-electric properties depend on very delicately balanced energy conditions, and their understanding presupposes a very thorough knowledge of the bonding of the crystal structure. It seems remarkable how much progress has been achieved in spite of the difficulties of the subject, even with regard to so complicated a substance as Rochelle salt[1].

Dr. D. F. Rushman (formerly of Philips Electrical, Ltd.) discussed the high permittivity titanates, such as barium titanate and its solid solutions with the titanates of other metals of the second group of the periodic system of elements.

These ceramic materials, the unusual electrical properties of which were discovered during the War, have considerable practical interest. In practice, barium titanate is prepared from barium carbonate and titanium dioxide at temperatures higher than 1,000° C. To form a dielectric it is crushed, sieved, and sintered at about 1,300° C., clay or other binder being added in small quantities, to reduce the porosity. The preparation is not simple, and care is required to produce a material of uniform quality. Dr. Rushman showed the effect of wrong firing conditions on the dielectric properties.

Dr. Rushman discussed in detail the experimental evidence which establishes the ferro-electric character of barium titanate and some of its solid solutions with other titanates. The permittivity-temperature curve shows a characteristic peak at the Curie point[2]. Saturation effects are shown very strikingly by the fall of the permittivity when the specimen is in a strong D.C. field, and the materials give characteristic hysteresis loops. It is possible to produce electrets, that is, specimens can be polarized and the polarization 'frozen in', producing a specimen analogous to a permanent magnet. The crystal structure[3] is tetragonal, with spontaneous polarization[4], in the ferro-electric temperature region and cubic, without spontaneous polarization, above the Curie point. The structural transition at the Curie point is curious in that the cubic and tetragonal phase co-exist over a temperature range of a few degrees. The specific heat has a λ point at the Curie temperature, a characteristic feature of ferro-electric and ferro-magnetic materials[5].

Dr. A. S. Devonshire (University of Bristol) dealt with the theory of dielectrics and ferro-electricity. He gave an account of original theoretical work on some features of ferro-electricity, and in particular on the spontaneous polarization in barium titanate.

The permanent polarization in titanates can be explained, Dr. Devonshire said, by the forces between electric dipoles. If a substance containing dipoles breaks up into long narrow domains polarized along their length and the net polarization is zero, the mutual potential energy of the dipoles is $-\frac{2}{3}\pi P^2$ per unit volume, where P is the polarization per unit volume. When an ionic crystal is polarized, it contains a set of pseudo-dipoles, formed by displacement of the ions. If the energy required to displace the ions is less than $\frac{2}{3}\pi P^2$, the polarized state will be the most stable one; that is, there will be a spontaneous polarization. Dr. Devonshire here directed attention to a difference between ferro-magnetism and ferro-electricity. The interaction between electric dipoles is a long-range force, that is, the force on dipoles is partly due to dipoles in distant parts of the domain. In contrast, the forces which orient the magnetic dipoles in a ferro-magnet are almost entirely forces between nearest neighbours; the long-range forces are relatively very small.

The ferro-electric properties of barium titanate are due to the structure having a spontaneous polarization at temperatures below the Curie point. Dr. Devonshire classified the effect of temperature on the spontaneous polarization under three headings: (1) Thermal expansion decreases the number of dipoles per unit volume. This means a decrease of polarization with temperature. (2) Thermal expansion decreases the restoring force on a displaced ion. This means an increase of polarization with temperature. (3) Thermal oscillations tend to decrease the polarization with increasing temperature. The first of these effects is relatively small. The second two effects have opposite sign, but the same order of magnitude, and it is not possible to predict on theoretical grounds which predominates. Experiment shows that the polarization disappears at high temperatures. Hence the third effect must be larger than the second.

The potential energy of the system is further decreased if the crystal expands along the direction of polarization so that it becomes more polarizable in that direction. This interaction between structure and polarization has the effect of increasing the change of polarization with temperature and accounts for the transition at the Curie point being of the first and not of the second kind.

In the discussion, Dr. Rushman directed attention to some properties reducing the practical usefulness of titanates. One of these is their relatively low breakdown strength. Owing to the minimum thickness required for mechanical reasons, this is no serious disadvantage unless voltages above 500 V. are used. Another disadvantage is the fact that the titanates, being ceramics, cannot be used in such thin layers as dielectrics like paper. The marked dependence upon temperature of the permittivity is also a drawback for general use. Dr. Rushman observed that in general a ferro-electric material can never be a really stable dielectric because its ferro-electric properties are due to a certain instability of its structure. Nevertheless, the high permittivity of the titanates makes them useful dielectric materials for special purposes.

Dr. H. F. Kay (University of Bristol) contributed data indicating the way in which domains in barium titanate single crystals are arranged. Domain boundaries follow 101 or 011 planes, and the domains are often laminar. Dr. Devonshire pointed out that this need not contradict his postulate that for the most favourable conditions of potential energy domains should be elongated. The large domains found optically may be subdivided into smaller domains of equal c direction but different direction of polarization. Dr. Kay then showed that the structural changes in barium titanate and solid solutions of barium and strontium titanate can be explained with surprising accuracy if one assumes the barium and oxygen ions to be rigid spheres with the conventionally accepted ionic radii. This assumption even gives the right value for the spontaneous polarization. However, as Dr. Kay pointed out, the physical meaning of the changes could scarcely be so simple.

Mr. M. G. Harwood (Philips Electrical, Ltd.) reported experimental results regarding the lattice parameters of the tetragonal, ferro-electric form of barium titanate over a wide range of temperature, directing particular attention to changes which occur at points below room temperature, where other workers had previously found anomalies in the dielectric properties. The axial ratio c/a, although on the whole increasing steadily with decreasing temperature, shows discontinuities at approximately $+5°$ and $-70°$ C., a sudden drop in the ratio being recorded at each of these temperatures. This was analysed in terms of anomalous changes of the lengths of the tetrad and diad axes, which at all other temperatures vary in a continuous and regular manner. X-ray and optical examination shows that at these two particular temperatures, where two structures co-exist over about 10° C., the domains change their direction of polarization in the absence of an applied electric field. The reason for this still awaits an explanation; but it may account for the peaks in permittivity at these points.

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[1] Mason, W. P., *Phys. Rev.*, 72, 854 (1947).

[2] For example, Rushman and Strivens, *Trans. Farad. Soc.*, A, **42**, 231 (1946).

[3] Megaw, *Proc. Roy. Soc.*, A, **189**, 261 (1947).

[4] Kay and Rhodes, *Nature*, **160**, 126 (1947). Hulm, *Nature*, **160**, 127 (1947).

[5] Harwood, Popper and Rushman, *Nature*, **160**, 58 (1947).

GEORGE STEPHENSON, 1781-1848

On August 12, 1848, a century ago, George Stephenson died at his home, Tapton House, Chesterfield, at the age of sixty-seven, and was buried in Trinity Church in that town. For some years he had been more concerned with his properties than with railways, taking special delight in horticulture and his Derbyshire collieries. His father had been a fireman at a Northumberland coal mine, and Stephenson himself had passed his boyhood amidst coal pits, pumping and winding engines. He had become an assistant fireman when fifteen, was the mechanical engineer at Killingworth Colliery at thirty-one, built his first colliery locomotive at thirty-three; his first railway was that laid down at Hetton mines a little later, and the famous Stockton and Darlington Railway, of which he was the engineer, was designed primarily for mineral traffic. His interest in collieries was therefore life-long.

The story of Stephenson's rise from obscurity to fame is a familiar one in industrial history. Born in the lowliest circumstances, he enjoyed none of the early advantages of Watt or Smeaton or Rennie, and it was only when eighteen, through his own perseverance and industry, he learnt to use a pen and entered the magical world of books. His mechanical ingenuity, however, was evident from the first; and it was only a year after he constructed his first locomotive, *Blucher*, that he devised the 'Geordie' miners' safety lamp, for which he was given £1,000 by his fellows. The reputation thus gained was increased by his success at Hetton, and at a time when the mechanical world was divided over the respective merits of horses, stationary engines and 'travelling engines' for industrial railways he was able to prevail upon the Darlington manufacturer, Edward Pease (1767–1858), to use locomotives, except for steep inclines, on the Stockton and Darlington line.

Moreover, through the confidence Stephenson inspired, he was enabled to secure the co-operation of Pease and others in founding the first locomotive-building works in the world. Set up at Newcastle in 1823, under the title R. Stephenson and Co., the firm supplied many of the most famous of all early locomotives. George Stephenson was then in his 'forties, his son Robert in his 'twenties, and it is impossible to dissociate the work of one from the other. Generally it may be stated that the period 1820–25 saw the construction and opening of the Stockton and Darlington Railway and the period 1825–30 the construction and opening of the much more important Liverpool and Manchester Railway, on which in 1829 took place the epoch-making Rainhill locomotive trials, which decisively placed the steam locomotive in the position of supremacy.

Needless to say, the steam railway would have come if George Stephenson had never lived; but it was his good fortune to be in the current of affairs at a critical time, and to be endowed with both the mental and physical characteristics necessary for the task which lay ahead. The locomotives of Trevithick, Hedley and Blenkinsop had preceded Stephenson's, while railroads or tramways had been in use a very long time. Then, too, many men, without any claims as inventors or engineers, saw what was possible, and their views were shared by men of high commercial standing. Before the Stockton and Darlington Railway was started and before Stephenson's factory at Newcastle was opened, in 1820 Thomas Gray, who died in poverty two months after Stephenson passed away, published his little book entitled "Observations on a General Iron Railway", which ran through five editions in five years, and contained plans for trunk lines from London to Falmouth, Dover, Edinburgh, Holyhead, etc. Still other promoters were William James, Nicolas Wood, the mining engineer, and Charles Maclaren, the editor of *The Scotsman*.

By this time the advancement of civil engineering and mechanical engineering in the eighteenth century had given Britain great constructional works and engine shops, the supply of iron for rails, boilers and engines was ample and many men were ready to follow in the footsteps of Stephenson. His lines and his shops, too, provided the training grounds for the future railway engineers, and so it was that with the completion of the Liverpool and Manchester Railway the great era of railway construction began. In Great Britain alone, by 1840 there were more than 800 miles of lines open, by 1860 more than 10,000 and by 1880 some 18,000 miles. Not a single engineer of those days would have denied that the world was entitled to regard George Stephenson as the 'father of railways'.

NEWS and VIEWS

Sir Francis Darwin (1848–1925)

THE third son of Charles Darwin gave early evidence of a scientific bent. Born at Down a century ago, on August 16, 1848, he took his degree at Cambridge in 1870 with a first class in the Natural Sciences Tripos. After studying medicine at St. George's Hospital, London, and obtaining the Cambridge M.B. in 1875, he acted as his father's secretary for eight years. In 1884 he was appointed lecturer, and four years later reader, in botany at Cambridge. At that time plant physiology was beginning to supersede the study of systematic botanical description. Francis Darwin's class-book "The Practical Physiology of Plants" (1894) went into several editions, for it was the first book of its kind in Britain. His researches on growth curvatures in plants and on the control of water-loss by plants attracted considerable attention. He was a popular lecturer, being engagingly simple and direct. Though possessed of strong prejudices and inclined to be intolerant, his was a lovable personality, charming, kindly and humorous. He was an accomplished musician and devoted to dogs, which, unlike human beings, never bored him. Many honours came his way. Elected a fellow of the Royal Society in 1882, he was foreign secretary during 1903–9 and vice-president in 1907. In the following year he became president of the British Association, and he was knighted in 1913. He died at Cambridge on September 19, 1925. It is appropriate that his best and best-known book should be the "Life and Letters of Charles Darwin" (1887).

Statistics of the Ministry of Labour and National Service

THE standing Interdepartmental Committee on Social and Economic Research was appointed in January 1947 to survey and advise upon research work in Government departments and in particular to bring to the notice of departments the potential value for research purposes of the material which they collect, and to suggest new methods and areas of collection. It has also to advise on how there could be made available to research workers information gathered for their own purposes by the departments which has potential value as material for research. The Committee has selected as the first major department for survey (London: H.M. Stationery Office. 9*d*. net) the Ministry of Labour and National Service, which has a tradition of co-operation with research workers. The first results of this survey have been published as a booklet which describes the development of the Ministry of Labour's Statistical Service and the information at present collected by the Ministry on employment and unemployment, wages, earnings, hours and industrial relations, retail prices and family budgets, the changes which have occurred in the form of collection and the effect upon the comparability of successive statistics. In addition to a list of published sources of information, there is included a subject index to published sources of Ministry of Labour statistics. The booklet is experimental in form; but it is hoped that it will prove of value to teachers and students in the universities as well as to other research workers, and criticism and suggestions for improvement will be welcomed by the Committee.

Marconi Transmitters for East Africa

A NEW system of short-wave radio communication is planned in East Africa, where a total of forty-eight Marconi short-wave transmitters are to be installed to provide a comprehensive communications network for ground-to-air and point-to-point communications for the rapidly expanding civil aviation services—both local and trunk routes—and for administrative, public and meteorological traffic. The new services, which will operate throughout the three territories of Kenya, Uganda and Tanganyika, are required to meet the needs of post-war expansion and re-organisation of the East Africa Posts and Telegraphs Department's Services. Two of the latest types of Marconi transmitters have been chosen for this new service. They are Type *TGS.* 541—a 200-watt transmitter with a frequency range of 1·5–23 Mc./s., and Type *TGS.* 501—a 100-watt set covering a frequency range of 1·5–13 Mc./s. Both types of transmitter are compact, easily operated equipments designed for operation on radiotelephony or telegraphy. Special features include crystal-control with provision for the rapid selection of any one of six working frequencies—a particularly useful asset where a large volume of traffic is handled. Frequency tolerances are well within the very fine limits laid down by international regulations. Work has already begun at the Marconi Company's Chelmsford Works on the construction of the first of these transmitters which are to be installed at Mbeya Airfield, Tanganyika.

Quarterly Journal of Mechanics and Applied Mathematics

THIS new journal is intended to provide a medium for the publication of papers on classical mechanics and mathematical techniques. The first number, dated March 1948, which has recently been issued, contains papers by D. C. Pack, R. Hill, D. R. Hartree and S. Johnston, W. G. Bickley, S. Goldstein, A. D. Young, M. J. Lighthill, and Sir Geoffrey Taylor. Rather more than half of these papers deal with hydrodynamics and its applications to aerodynamics or internal ballistics; the others deal with elasticity or methods and results useful in computation. The editors are Prof. G. C. McVittie and Prof. V. C. A. Ferraro, assisted by an editorial board which includes most of the leading British applied mathematicians. The publishers are the Oxford University Press, and the subscription is £2 a year for the four numbers.

Earthquakes during June

DURING June there occurred at least nine world-shaking earthquakes and a great number of smaller ones. The greatest two of the month were that on June 28, which caused heavy casualties and severe property damage in and around Fukui, West Honshu, Japan (*Nature*, July 10, p. 57) and which gave ground amplitudes at Durham of 115μ, and that on June 30, which caused casualties and property damage on the island of Levkas and the nearby mainland of Greece, and gave ground amplitudes of 220μ at Kew. The other great shocks were on June 15 near the southern coast of Honshu, Japan; on June 18 in the Solomon Islands region; on June 21 in the Celebes Sea; on June 27 (2) off the northern coast of Honduras and south of the Alaska Peninsula; and on June 29 (2) in the Samoan Islands region and in Transcaucasia. An earthquake only slightly less intense occurred on June 13 from a focus the epicentre of which was near lat. 43° 31′ N., long. 12° 8′ E. This caused some property damage and at least one death at San

Sepolcro in the Italian Province of Arezzo. Also during the month there was a swarm of earthquakes in the Karlsruhe, Rasstat, Lauterbourg area. The swarm began on June 1 and lasted practically the whole month, the greatest shock of the series being felt on June 7 with scale VI to VII (some chimneys down) at Karlsruhe. The epicentre of this shock was near lat. 49° 04′ N., long. 8° 19′ E. some 9 km. north-west of Karlsruhe, and the depth of focus has been estimated at 20–30 km. The energy of the shocks of this swarm did not travel far, but was recorded by the seismographs at Strasbourg, Stuttgart and the Swiss observatories. Apart from the observatories mentioned above, reports for the month have also been received from the U.S. Coast and Geodetic Survey, Aberdeen, Beograd, Cleveland (Ohio), De Bilt, Toledo and Uccle.

Galactic Noise

R. v. d. R. Woolley has discussed in a recent paper (*Mon. Not. Roy. Astro. Soc.*, **107**, 3; 1948) the theory of the origin of the galactic radiation. Since radio workers consider it short-wave radiation and spectroscopists regard it as very long-wave radiation, it is undesirable to refer to it by a name embodying any idea of wave-length, and the appropriate term 'noise' has been adopted since it can be heard on the earphones. Eddington discussed the temperature of interstellar space in "The Internal Constitution of the Stars", and estimated it at about 10,000°; but later he suggested that the absorption in space of ultra-violet quanta would reduce the temperature. (By temperature he meant the parameter appearing in the Maxwellian velocity distribution of the free electrons.) Woolley investigates the problems of temperature and the degree of ionization in interstellar space, and concludes that if the noise is due to free-free transitions, it must certainly come from hot regions in interstellar space and almost certainly from regions where the density is above the average. In these circumstances, if 'cold' regions, that is, regions of low hydrogen ionization, do not contribute appreciably to the noise, then an observed amount of galactic noise from a particular part of the sky implies a minimum bright hydrogen emission from that part. If observation fails to reveal this bright hydrogen emission, the only conclusion is that galactic noise is not due to free-free transitions. If the noise is due to free-free transitions, it is shown that the minimum number of $H\alpha$ quanta received per sq. cm. per second per unit solid angle of the sky is within reach of observation with modern equipment.

Cinematograph Films of Living Cells

C. C. Speidel (*Amer. Scientist*, 36, 237; 1948) describes with some very fine illustrations the results he has obtained by fast cinematography of cells inside the living animal. He used regenerating tail tissue of the tadpole for his observations, and shows that cellular organisation may be studied here with results which tissue cultures cannot provide. Regeneration of nerve fibres, showing the manner in which their direction and anastomosing take place, mitosis in a nerve cell and the relative movements of the two daughter nuclei, the movement of lymphocytes and diapedesis of leucocytes are among the many beautiful results of this method of observation. The salvaging of extravasated blood cell by cell by the sprouting of a lymph vessel is startling, while the movement of muscle fibres in contraction and relaxation may be followed step by step. It would seem that this method of analysis would be of great value in further studies of development, especially in the little-known differentiation of plant tissues.

Tests of Mosquito Repellents

When Australian forces began campaigning during the Second World War in the highly malarious islands of the south-west Pacific area, a very urgent need was an effective mosquito repellent. Bulletin No. 213 (1947) of the Commonwealth of Australia Council for Scientific and Industrial Research describes laboratory and field tests conducted by Major R. N. McCullough and Capt. D. F. Waterhouse with this object in view. More than 125 substances were tested for use as repellents against both anopheline and culicine mosquitoes. The chief species used in these experiments were *Anopheles punctulatus farauti*, the yellow-fever mosquito *Aedes ægypti*, and the common pest mosquito *Aedes vigilax*. The work involved was a co-operative investigation between the Council for Scientific and Industrial Research and the Army. Taking all factors into account, dimethyl phthalate was by far the most satisfactory repellent tested. Also, it is almost completely odourless and has very little or no irritant effect on the skin of the hands and face, to which it is applied. A number of other synthetic and naturally occurring substances were tested with indifferent results. Many essential oils were quite ineffective, while the two most promising were too irritant to use. Pyrethrum preparations gave consistently poor results. The treatment of clothing with dimethyl phthalate prevented mosquitoes from attacking through the material, except to a very limited degree, up to 72 hours after application. As a result of these investigations of repellents, and of those on a larger scale in the United States, the manufacture of adequate quantities of dimethyl phthalate was organised and the substance made available to the Australian fighting forces in 1943, some special forces being supplied with it as early as March 1943.

Control of Weeds

Prof. G. E. Blackman, in a short paper on "Recent Developments in the Control of Weeds" (*J. Roy. Hort. Soc.*, 73, 5; May, 1948), summarizes some useful results on the effectiveness of various selective weed-killers. Sulphuric acid gave the best control of goosegrass, *Galium aparine*; methyl-chloro-phenoxy-acetic acid gave the best kill of shepherd's needle, *Scandix pecten-veneris*, and common red poppy, *Papaver rhœas*; and dinitro-*ortho*-cresol was most toxic to scentless mayweed, *Matricaria inodora*, but also gave control equal to the acetic acid compound of *P. rhœas*. The use of sulphuric acid is still most effective, particularly against weeds of the onion crop. Spraying with this acid gives about 90 per cent of the yield obtained by hand weeding and hoeing, but at very much less expense in labour. Charlock is susceptible to control by growth-substance sprays at all stages from seedling to flowering, though poppies are susceptible only as seedlings.

Tomato Spotted Wilt Virus

The disease of tomatoes caused by spotted wilt virus often shows considerable variation in severity. D. O. Norris has now shown (Bull. 202, Coun. Sci. and Ind. Res., Australia; Melbourne, 1946) that this is due to varying combinations of at least five strains of the virus. The paper describes and figures the symptoms of these strains on sixteen host species, and indicates suitable tests for the presence of strains in a particular disease. The thermal death-point of spotted wilt complexes is considered to be about 10° C. higher than the usual value of 42° C. This is a rather unwelcome discovery from the point of view of possible control. On the other hand, the finding of a high degree of resistance to spotted wilt by *Lycopersicum peruvianum* is likely to be of considerable importance in breeding.

Clutch and Brood-size in the Robin

The inquiry into clutch and brood-size in the robin (*Erithacus rubecula*), which was first reported by David Lack in 1946, has now been closed. Later observations show that the breeding season in Holland is later than in Britain but is earlier in North France, Germany and Switzerland than inland in Europe at a similar latitude (*British Birds*, 41, No. 4; April, 1948). The tendency for the average clutch-size of the robin in England and Wales to be highest in May, lower in April, and lower still in March, June and July has been confirmed It has also been shown that the average clutch-size is different in different years and there may be a correlation between fine weather and higher clutch-size. The average clutch-size in Ireland is approximately the same as in England and Wales, but in Scotland the average clutch-size is higher than in England and Wales. Nesting is more successful in May than in April, possibly because in April the ground vegetation is not so well grown as in May, leaving the nests less exposed to predators.

International Committee for Bird Preservation

The report of the British Section of the International Committee for Bird Preservation (The Secretary, c/o British Museum (Natural History), Cromwell Road, London, S.W.7) is a record of much good work. For some years past naturalists and others have been perturbed by the decline in the wildfowl population of the world, and, among other things, the report contains an account of the Committee's work in investigating the situation as it affects the wildfowl of Europe. Among the activities are the ringing of duck to trace their migration routes. A duck decoy at Orielton is being used for this purpose, and ringing on a lesser scale is being carried out at other decoys in Great Britain. In 1947, the headquarters of the Committee, previously in Brussels, were transferred to London, and the British Museum (Natural History) is now the centre of the organisation, which has thirty-four national sections from all five continents.

The Film in Scientific Research

The Sciences Committee of the Scientific Film Association is arranging a one-day conference on "The Film in Scientific Research", to be held on October 12 at the Royal Institution, London. The chair will be taken by Mr. J. E. Cummins, chief scientific liaison officer in London of the Australian Government, and the Conference will be opened by Sir Robert Watson-Watt. The Conference will include discussions by British and foreign men of science on the value of scientific films as a research tool in various branches of science; the function of the research film in giving up-to-date information in a particular field; scientific films as an aid to the training of scientific workers; scientific films as a medium for explaining to the general public important results of scientific research; and technical aspects of the use of films in scientific research. The Conference will conclude with a two-hour showing of British and foreign research films. Material suggested for discussion and information as to the existence or availability of research films suitable for showing at the Conference should be sent to the Honorary Secretary, Sciences Committee, Scientific Film Association, 34 Soho Square, London, W.1, as soon as possible.

Announcements

We regret to announce the following deaths:

Mr. S. G. Brown, F.R.S., known for his work on the gyroscopic compass and numerous other mechanical instruments, on August 7, aged seventy-five.

Mr. Harry E. Burton, principal astronomer and head of the Equatorial Division of the U.S. Naval Observatory from 1929 until June 30, 1948, on July 19, aged seventy.

Mr. J. R. Cowie, chairman of Council of the British Electrical and Allied Industries Research Association, on August 5.

Dr. Henry Guppy, C.B.E., librarian of the John Rylands Library, Manchester, on August 4, aged eighty-six.

The chairman of the Royal Society's Library Committee, Prof. E. N. da C. Andrade, has accepted an invitation by the Council to become honorary librarian to the Society during his tenure of chairmanship of the Library Committee.

Sir Lewis Fermor, director of the Geological Survey of India during 1932–35, has been elected *Correspondant Etranger* of the Société Géologique de France.

Sir Frank Stockdale, chairman of the Colonial Development Corporation, has been appointed chairman of the governing body of the Imperial College of Tropical Agriculture, in succession to Sir Eric Macfadyen, who has been associated with the College since 1928.

Mr. Seton Lloyd, technical adviser to the Directorate of Antiquities in the Government of Iraq, has been appointed director of the British Institute of Archæology at Ankara in succession to Prof. J. Garstang, as from March 1, 1949.

Mr. R. McChlery, former Rhodes scholar and, since 1926, a member of the Agricultural Department, Salisbury, has been seconded to the Central African Council to take up the new appointment of Central African Scientific Liaison Officer in the United Kingdom, and to establish a Central African Scientific Liaison Office in the British Commonwealth of Nations Scientific Offices, London.

Dr. A. E. A. Werner has recently joined the staff of the National Gallery, Trafalgar Square, as research chemist. He was previously reader in chemistry in Trinity College, Dublin.

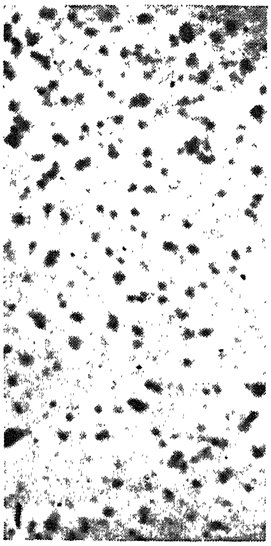
A Conference of German Hygienists and Microbiologists is being held at Stuttgart during August 25–27. Among the topics to be discussed are: tuberculosis in animals and its chemotherapy; immunization against virus diseases; milk hygiene in Germany; human helminthiasis and its chemotherapy; human and animal trichinosis; rickettsia toxins; morphology and ecology of bacteria; bacteriology of enteritis; serum reactions, etc. Particulars can be obtained from Prof. G. Lutz, Heusteigstr. 66, Stuttgart-S.

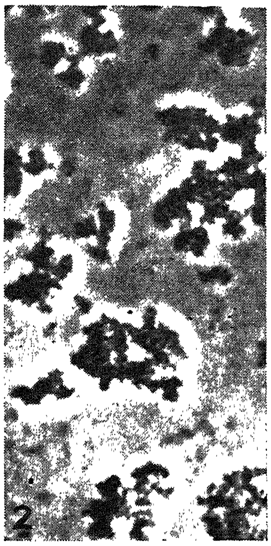
LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Phase-Contrast Microscopy of Viruses

THOSE who have used phase-contrast microscopy will have been impressed by the apparent high resolving power of the method. It is frequently possible to observe very fine fibrils and particles with a clarity hitherto only obtained by dark-ground illumination. Thus, I have observed living *Leptospira*, said to be only 0·15 μ in width, as well as very small granules inside bacteria.





It was to be expected, therefore, that at least the larger viruses would be visible by phase-contrast illumination, and this has now been verified. Fig. 1 shows a smear of psittacosis virus (× 1600), and Fig. 2 one of vaccinia (× 1600). The preparations were unstained and mounted in water. It is important to distinguish between *visibility* and *resolution* of the particles. The photographs were taken with commercial (Cooke, Troughton and Simms) equipment, using an oil immersion lens, rated N.A. 1·3 with phase-ring diameter approximately two thirds of the aperture. The expected resolution under these conditions, using green light, would be of the order of 0·3 μ. One would thus scarcely expect to obtain a true resolution of virus particles; but that does not preclude the possibility of detecting their presence. Thus, the vaccinia particles seemed spherical, not barrel-shaped, as in the electron microscope. The latter appearance may, of course, be due to a drying artefact.

As a rough approximation, it would be expected that particles below the limit of resolution would appear to remain about the same order of size, but would have less contrast, appearing in shades of grey instead of black. The visibility of small particles in the phase-contrast microscope depends on contrast, which is in turn governed by the refractive index of the particles and by the characteristics of the apparatus. Leaving aside the possibility of improving contrast by variation of the refractive index of the mounting medium, perhaps the most hopeful method of increasing the visibility is by alteration of the phase, and particularly the amplitude, characteristics of the phase plate. Given favourable material, there is probably no reason why much smaller viruses should not be seen, using a strongly absorbing phase plate with an intense light source.

It remains to be seen how useful the method will prove in virus research. It is valuable in that it allows fresh unstained material to be used; but it is, of course, non-specific and there is no simple means of distinguishing viruses from other small particles. An obvious application is to the study of the development of virus bodies in living cells.

I wish to thank Prof. S. P. Bedson for supplying the virus material.

ROBERT BARER

Department of Human Anatomy,
Oxford.
July 10.

Experimental Hydronephrosis Studied by the Colchicine Method

THE colchicine method was first used to study compensatory hypertrophy of the kidney by A. P. Dustin and S. Zylberszac[1,2], who noticed that a few days after ligation of the ureter, colchicine induced numerous 'stathmocineses' (arrested mitoses) in the kidney (Fig. 1).

This phenomenon has been reinvestigated in the adult rat, nine hours after injection of 2·0 mgm./kgm. of colchicine, mitosis being counted in the obstructed and the opposite kidneys. The total number of divisions was counted in median sections and, in order to compare the figures more accurately, these were corrected per 100 gm. of animal weight (Fig. 2).

In the obstructed kidney, two days after ligation, numerous stathmocineses are found in the interstitial cells, convoluted tubules, loops of Henle, distal convoluted tubules and collecting tubules. None is seen in the glomeruli. The mitoses remain numerous during the five succeeding days, especially in the proximal convoluted tubules. After one week, mitoses decrease as the kidney undergoes progressive atrophy through dilatation of the pelvis. In the opposite kidney, mitoses in the tubules increase on the

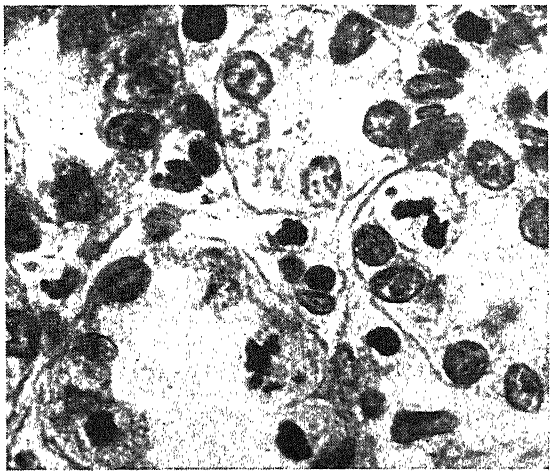


Fig. 1. Stathmocineses in convoluted tubules six days after renal obstruction

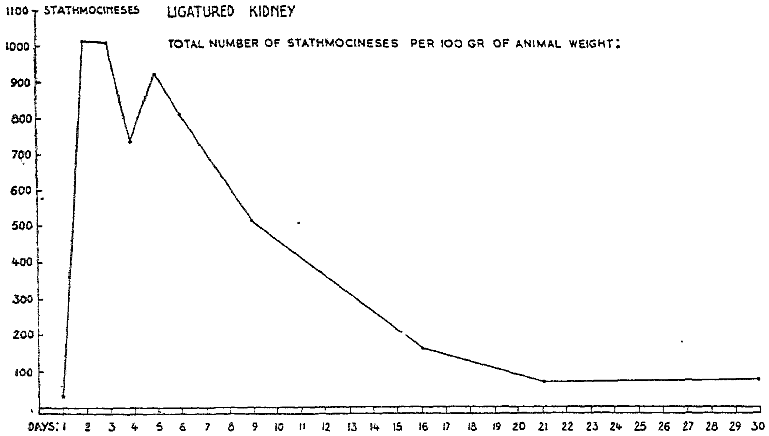


Fig. 2

second day after ligation, and reach a maximum at four days. The number of these mitoses remains at about the same level for as much as thirty days, the level being similar to that observed by the same method in compensatory hypertrophy.

These results are, in our opinion[3], comparable with those of Hartman[4], and Bollman and Mann[5]. These authors created uretero-intestinal fistulæ, leading to a slow reabsorption of urine in the intestine. They observed hypertrophy of the kidneys and also an acceleration of compensatory hypertrophy, with numerous mitoses in the tubules. Wilson[6] supposed that the hypertrophy of the kidneys may be induced by some urinary components. In hydronephrosis, their reabsorption by the kidney tubules would first promote mitoses in the ligated kidney. Soon after, these same substances, taken back by the general circulation, would stimulate cellular proliferation in the opposite kidney.

These experiments may be expected to throw more light not only on the mechanism of compensatory hypertrophy, but also on the chemical nature of the stimulus. Detailed results will be published shortly in the *Bulletin de l'Académie Royale de Médecine de Belgique*.

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June 30.

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Induced Adenocarcinoma of the Stomach in Mice

THE great rarity of malignant tumours in the glandular stomach of all lower animals is generally admitted. The only records of spontaneous adenocarcinoma in mice seem to be three cases among 142,000 post-mortem examinations by Wells, Slye and Holmes[1], two in *Mus musculus* and one in *Peromyscus*. Strong[2] has reported adenocarcinoma in mice of his *NHO* line, derived from ancestors injected with methylcholanthrene and selected for resistance to local sarcoma-induction; but these animals are not representative of the species.

Two series of mice fed by us with cotton-seed oil previously heated to 350° C. for four hours have yielded tumours of the stomach unlike any that we have seen in other mice of similar age, in a variety of experiments during the past twenty years.

In the first series, forty-eight mice of mixed stock bred in this laboratory were fed on rat-cake[3], and drank daily a solution of heated cotton-seed oil (40 ml.) plus croton oil (4 ml.) dissolved in ether soap solution (356 ml.)[4], diluted with ten volumes of water. During the first year of experiment the ether was evaporated; but afterwards this was not done, as it was thought that the ether might improve the miscibility of the oil with the gastric contents. This solution contained 1·0 per cent of heated cotton-seed oil and 0·1 per cent croton oil, later reduced to 0·05 per cent because some animals died with hæmorrhages from the *pars glandularis* of the stomach. The average daily consumption per mouse was 5 ml.

Of nine mice that survived for eighteen months, two developed papillomas of the fore-stomach and one died with a massive malignant tumour involving both parts of the stomach. This tumour showed evidence of multiple points of origin and included squamous papilloma and carcinoma in the fore-stomach and adenoacanthoma in the glandular stomach. There was a secondary deposit of the latter type of tumour in a mesenteric lymph node. The last survivor of this group died after twenty-nine months of experiment, with four papillomas in the fore-stomach but no lesion of the glandular stomach.

In repetitions of this experiment, only tumours of the fore-stomach have so far occurred.

These experiments are summarized in the accompanying table.

In the second series of experiments, mice of similar origin were fed on powdered rat-cake containing 0·5 per cent by weight of black pepper. The drinking water contained 1·0 per cent heated cotton-seed oil in soap solution as previously described. Of five

Diet	Initial No. of mice	Stomach tumour incidence in survivors after first tumour	Duration of expt. at time of first tumour (days)	Diagnosis
Heated cotton-seed oil plus croton oil	48	3/9	540	Single squamous papilloma; 1 mixed squamous papilloma, squamous carcinoma and adenoacanthoma; 4 squamous papillomas
	12	1/3	387	1 big papilloma
	12	1/9	406	1 small papilloma
	12	1/5	452	1 medium papilloma
Croton oil only	12	1/6	487	1 small papilloma
Unheated cotton-seed oil only	12	1/11	310	Polyposis of pyloric canal
Cotton-seed oil plus croton oil	12	1/2	501	Polyp in duodenum close to pylorus

survivors for sixteen months, one died at that time with a large ulcerated tumour involving the pylorus and proximal part of the duodenum. This proved to be an adenocarcinoma, which had invaded the pancreas and a lymph node by direct extension. The other four survivors are still living after twenty-four months of experiment.

In another experiment, twelve mice on similar diet yielded no tumours in two that survived for more than fifteen months. In 309 mice of similar origin in other experiments not involving known carcinogens, no gastric tumours were found.

We have not been able to identify any known carcinogen in any of the heated fats or lipids, examined by methods that will detect one part in ten million of 3 : 4-benzpyrene. Moreover, even the presence of traces of known carcinogens would not account for the induction of adenocarcinoma of the stomach, since very large numbers of mice have been painted with potent carcinogens in many laboratories and must have licked off and swallowed considerable amounts without a single case of gastric adenocarcinoma being recorded. In this laboratory, mice fed with known carcinogens have frequently developed papilloma and carcinoma of the fore-stomach, but no tumours of the glandular stomach have occurred.

Evidence that heated fats and lipids contain potential carcinogens was recently reviewed by one of us[5]; but the induction of stomach tumours in mice in feeding experiments with such substances are few and not generally accepted. Waterman[6] claimed one case of adenocarcinoma of the stomach in a mouse fed with heated cholesterol oleate; but this has not been confirmed. Roffo[7] made numerous claims to have induced adenocarcinoma of the stomachs of rats fed on a variety of heated fats; but his copious illustrations do not support this diagnosis, and the work has not been confirmed. The two cases reported here cannot be statistically assessed; but it seems more probable that they were the result of the experiment than of chance.

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Physical Nature of Mouse Brain

Most histologists refer to the possible existence of a ground substance in the brain. Neurofibrils or glial fibres of the cortex impregnated in a successful silver preparation by no means completely fill the space available. Presumably in life these nerve terminals and glial fibres are even further separated from one another, since the processes of fixation, dehydration, etc., produce considerable shrinkage.

The physical properties of mouse brain as a whole, or of a piece of excised cortex, suggest that this is a substance with a continuous structure resembling that of a firm paste. It is opaque, soft, sticky, almost plastic, with a marked avidity for water.

Using either direct or dark-ground illumination, a film of fresh brain tissue appears granular, the separate granules adhering to one another and giving the whole field a hazy appearance. This granularity is evident at a magnification of × 80 and is best studied by means of dark-ground illumination at × 1,000 [1]. Even at this magnification separate granules are not distinct. Some show Brownian movement; but the majority adhere to one another, forming a more or less continuous film. Pressure on the coverslip causes sluggish streaming movements; but on releasing the pressure the displaced parts recoil and the original appearance is restored. A piece of fresh cortex was placed in 1 per cent aqueous methylene blue for one minute, crushed between two slides and examined by direct illumination. Movement between the two slides or light pressure caused streaming displacements of the blue cortical cells in an unstained granular matrix. On cessation of movement or release of pressure the original grouping of cells was restored. The cells themselves showed marked elasticity and could not be ruptured. They were intact, suggesting that the granularity was not due to cell debris. Heavier pressure merely thinned the film by causing a gliding movement of brain substance towards the edge of the preparation with extrusion beneath the borders of the covering slide.

It has been pointed out that the cells and fibrils impregnated with silver do not occupy all the available space in a histological preparation. It seems improbable that the granularity described merely represents the fresh state of those structures which become impregnated with silver in fixed tissue. A strong impression is received that this granular substance is the ground substance of the brain, being present in considerable quantity in the mouse cortex.

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Some Unusual Findings on the Carcinogenic Action of Urethane in Mice

The induction of pulmonary tumours in mice following ethyl carbamate (urethane) treatment was originally described by Nettleship, Henshaw and Meyer[1] and has been confirmed by numerous workers. Similar effects of urethane in the rat have been noted by Jaffe[2]. The lung tumours described have been adenomata, usually multiple, appearing by three months after oral or injected, single or multiple doses of urethane (solutions of 5 or 10 per cent). In histological appearance the tumours are the same as spontaneous lung tumours arising in strain *A* mice and are of relatively low-grade malignancy. Successful transplantation has not been reported. The findings reported below were obtained on Rockland 'Swiss' albino mice in experiments investigating the carcinogenic action of urethane. The preliminary results obtained are so unusual that they are presented in a very incomplete form, so that the effects may be looked for by other investigators and the apparent action considered by those using urethane for clinical therapy. More detailed results will be presented shortly from a repetition of these and other experiments now in progress.

(1) Seven young female mice, 20 gm., received a single subcutaneous injection of 25 per cent urethane in a 5 per cent solution of zinc acetate, 0·1 c.c. per 10 gm. body weight, with the view of slow absorption. Such an injection caused a local tissue necrosis which healed in two to three weeks. After three months and four months respectively, in two mice a rapid general enlargement of lymph glands was noted. Both animals, at autopsy three weeks later, showed extensive lymphosarcoma, all glands being involved and markedly enlarged. Histologically the tumours were highly malignant, and extensive spread to gut, liver and kidneys was noted. The usual lung adenomata were also present. A third mouse after five months developed a slower growing tumour behind the humerus (at least one inch from the injection site). At autopsy a large, spongy, blood-filled tumour was found. Histologically the sections showed a malignant hæmangio-endothelioma, and no metastases were noted. Lung adenomata were present. Spontaneous malignant tumours of these types have never been observed in more than a hundred mice of the same strain and age used for other experiments in the laboratory. Control experiments using 25 per cent urethane and 5 per cent zinc acetate alone, and other substances causing retardation of absorption[3], are not yet complete.

(2) The lungs of a mouse containing multiple large adenomata induced by previous urethane treatment (discontinued for the previous five months) were ground in saline and injected into sixteen mice. One half of the group received intrapleural, and the other half subcutaneous, injections. After six months, four of each group were killed. Two mice of the first group and all four mice of the second group showed single or multiple lung adenomata. These tumours were typical of those induced by urethane injections.

(3) The lungs of mice which had received a single subcutaneous injection of 0·1 c.c. per 10 gm. body-weight of 5 per cent urethane 3, 6, or 24 hours previously were ground up and injected into normal female mice. The equivalent of one lung was given to each animal by subcutaneous injection. Four animals of each of these three groups were killed five to six months later. Eleven of the twelve animals showed single or multiple lung adenomata similar in all respects to those caused by urethane injections. No other lesions were noted.

(4) Experiments using lung suspensions similar to those of paragraph (3), but made from animals which had received three daily injections of urethane, showed the same result, three of four mice developing lung adenomata.

(5) One control experiment was performed in which lungs from normal uninjected mice were administered in the same fashion under the same conditions. At autopsy, three mice which had received the injections did not show any lung adenomata.

It is obviously inadvisable to speculate on the significance of these preliminary experiments until more extensive ones have been completed. It appears, however, that rapidly growing, highly malignant tumours have been produced in mice following the injections of a strong urethane solution and zinc acetate. In other experiments a suspension of the lungs of mice which had received small doses of urethane, when given subcutaneously, produced adenomata of the lungs in a high percentage of animals. Although it is possible that the injected urethane might be concentrated in the lung tissue, there was no experimental evidence to suggest this as the explanation of these observations.

This work has been carried out with grants in aid from the National Cancer Institute of Canada and the Ontario Cancer Research Foundation.

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Reaction of Effector Cells to Chemical Transmitters

EARLIER work has led us to the view that the intervention of peripheral elements has a fundamental role in the regulation of nervous activity[1]. This regulation, in fact, is not exclusively conditioned by the nature of the transmitter or by its mode of formation. It depends to a great extent on the more or less specific reactions of the effector cells to the substances liberated by nerve stimulation. Thus two transmitters, acetylcholine and adrenalin, act in a different way on organs like the heart and the intestines, which present different histological structures. But adrenalin causes contraction of the uterus of the pregnant cat and relaxation of the uterus of the non-pregnant cat, that is, the action of the same transmitter is dependent on the functional conditions of the reacting tissue. This suggests the possibility of local intervention of sex hormones in the peripheral regulation mechanisms of the uterus; for it has been shown by Courrier that these hormones are capable of direct action on that organ and that the hormonal antagonism between œstrin and progesterone, for example, is directly concerned with its effector cells.

We have therefore carried out more general experiments on the isolated uterus of the rabbit, which was the test-organ of Courrier, to find out to what extent the responses of this organ to acetylcholine and adrenalin may be influenced by previous treatment with different sex hormones.

The rabbit uterus reacts to acetylcholine as well as to adrenalin by contraction. This analogous action is remarkable; for the effects of both are not only inhibited by atropine, but also sensitized by eserine. The actions of the two transmitters can, however, be differentiated by yohimbine, which reduces the effect of adrenalin without modifying that of acetylcholine; and we observed also that relatively small doses of adrenalin could produce contractions in uteri which showed very slight sensitivity to acetylcholine. It thus appears scarcely likely that adrenalin produces its contracting effect by mobilizing acetylcholine in that organ.

This curious synergism of the two transmitters is not affected by sex hormones. The untreated uterus of very young animals is absolutely insensitive to the two substances, and becomes sensitive to both after 30–50 γ of œstrin have been administered to the animals over a period of several days. The same modifications occur with the uteri of ovariectomized rabbits. This evolution of sensitivity: (1) does not increase with the administration of larger amounts of the hormone than the active dose; (2) is not peculiar to œstrin, but can also be obtained with testosterone (1–10 mgm.), progesterone (1–10 mgm.), desoxycorticosterone (1–10 mgm.), or with a mixture of œstrin and progesterone initiating the classical transformation of the uterus mucosa described as 'dentelle'. The reaction of the uterus to the transmitters seems, however, more marked after the administration of testosterone or œstrin than after that of desoxycorticosterone.

But this apparent uniformity of response hides very complex cell changes. When the rabbit uterus is immersed in Tyrode solution for 15–90 min. in the presence of oxygen and at a temperature of about 37°, it gives off a substance which is capable of decreasing the muscular tone of an isolated intestine preparation. This tone can be increased by the fluid obtained in the same circumstances from the uterus of an animal which has been treated with testosterone. The latter effect may also be observed, though generally to a lesser extent, with fluids obtained from rabbit uteri treated with progesterone alone or combined with œstrin. The liquid obtained after desoxycorticosterone sometimes provokes an amplification of the spontaneous intestinal movements. We conclude from these results that sex hormones are capable of creating modifications in the biochemical reactivity of the receptor cells of the uterus which may result in the secretion of substances capable of influencing in a more general way the tone of unstriated muscles, and of acting by this indirect mechanism on the humoral agents of the autonomic nervous system.

These results, however, do not explain why the same transmitter, adrenalin, causes the uterus of the rabbit to contract and the uterus of the guinea pig to relax, that is, of animals of the same species presenting analogous hormonal levels. We therefore administered a small dose of adrenalin to the isolated rabbit uterus and transferred, after contact varying from 15 to 40 min., the surrounding fluid to an isolated guinea pig uterus. This fluid produced a contraction of the guinea pig uterus which originally reacted to the administration of adrenalin with relaxation. The effect is not reciprocal in character; fluid obtained after the action of adrenalin on the guinea pig uterus still has a contracting effect on a rabbit uterus. On the other hand, when the fluid containing adrenalin after having been in contact with the rabbit uterus is transferred to the isolated intestine, it causes the usual inhibitory action of adrenalin on that organ, and a fluid containing adrenalin after having been in contact with the small intestine continues to produce contraction of the isolated rabbit uterus.

These findings suggest the presence of a special agent in the rabbit uterus conditioning the paradoxical action of adrenalin on that organ. They suggest in a more general way that the biological analysis of isotonic liquids which have been in contact during various periods and under various conditions with isolated organs may constitute a profitable method for the study of the behaviour of effector cells.

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A Nemestrinid Parasite of *Schistocerca gregaria* (Forsk.)

DURING dissections of an immature male specimen of the desert locust, *Schistocerca gregaria* (Forskål), a yellowish larva of Nemestrinidæ was found feeding on the testes and the surrounding adipose tissue. It was 1 cm. long. Its posterior end was surrounded by a chitinous cup leading to a slender respiratory tube c. 2 cm. long, which was constricted transversally along its whole length (these constrictions disappear when pressed during the preparation). The respiratory tube went longitudinally along the midgut and then was bent at right-angles towards the spiracle of the first abdominal segment. The tube was more or less uniform in width, becoming dilated at the cup surrounding the posterior spiracle of the larva. The end of the tube entered the meeting place of the tracheæ, which was considerably expanded. The chitin of this end was blackish-brown, due to pathological changes.

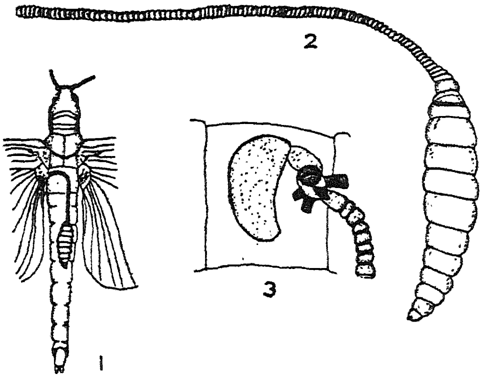

Fig. 1. *Schistocerca* dissected showing the Nemestrinid larva with the respiratory tube. ½ Nat. size
Fig. 2. Nemestrinid larva with the respiratory tube. × 3
Fig. 3. The spiracle, tympanal organ and the respiratory tube shown from inside

Potgieter[1] has described a Nemestrinid *Simmictus costatus* (Lw.) developing inside the body of *Locustana pardalina* (Wlk.) in South Africa. Noble[2] described larvæ, pupa and adult of *Trichopsidea œstracea* (Westw.) from *Chortoicetes terminifera* (Wlk.) in Australia. Fuller[3] has given a full description of *Trichopsidea œstracea* (Westw.) on various grasshoppers there. Crouzel and Salavin[4] described in detail two species of *Neorhynchocephalus*, *N. sulphurous* (Wied.) and *N. vitripennis* (Wied.) parasitizing the Acrididæ *Trigonophymus arrogans* Stal. and *T. elongatus* Giglio-Tos.

Unfortunately, our larva remained unidentified, as the attempt to transfer it into the body of another grasshopper failed. According to Dr. B. P. Uvarov (in correspondence), this is the first record of a Nemestrinid parasite of *Schistocerca gregaria*. I wish to express my thanks to Dr. Uvarov for his help and criticism in the preparation of this note.

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Antiquity of Man in Australia

For nearly eighty years, one of the most prominent items of anatomical evidence in support of the antiquity of man in Australia has been a fragment of a supposed human molar, found by Krefft in the Wellington Caves of New South Wales.

Early doubts expressed as to the value of its evidence were based on the possibility of its adventitious presence in the caves. These doubts were afterwards dispelled by eye-witnesses, and it is now accepted that the tooth, when found, was imbedded in the characteristic cave breccia, together with remains of *Diprotodon* and *Thylacoleo*. According to the estimate of Sir Edgworth David in 1923, the association dates back to a period 7,000–12,000 years ago.

The fossil has been discussed by Krefft (1870–74), Etheridge (1890–1916), David (1923) and Anderson (1933), all of whom have accepted its human origin.

Recently, the human origin of the fragment has been questioned by Dr. T. D. Campbell, and I have considered *de novo* its possible relation to the lower mammals. To this end, the morphology of the fragment and the type and sequence of the attrition which have produced its crown pattern have been minutely compared with all indigenous Australian mammals, with all introduced and domestic mammals, and with many exotic species as well, which could possibly yield a dental fragment of the size of the fossil. Three chief results have accrued from this examination.

(1) The fossil is derived from a tooth possessing extreme functional brachydonty. At the same time, the occlusal surface exhibits large exposures of dentine in juxtaposition with broad enamel structures. While both features may be separately found in the molars of a few mammals, their concurrence in the same species is generally precluded by the structural ground-plan of the tooth. Consideration of this fundamental peculiarity of the fossil early led me to abandon the view that it was a molar tooth at all.

(2) On transferring attention to premolar teeth, close analogies in structure were soon found to exist between the fossil and the third and fourth premolars of the Macropodinæ, in an advanced stage of wear. In particular, the highly characteristic pattern of the occlusal surface of the fossil is very closely reproduced in the premolars of the black-tailed wallaby (*Macropus walabatus* L. and G.), and a study of the successive stages of attrition through which such teeth have passed correlates in the clearest way all the main structures of the fossil, with their originating centres in the unworn premolar.

(3) After direct comparison with relevant material, and with the above general conclusions as a guide, I have no doubt that Krefft's find was derived from the posterior half of the upper fourth premolar or seccator, of the right side, of *Macropus* (*Protemnodon*) *anak*, Owen, a giant Pleistocene 'wallaby', remains of which are already known from the caves, and which occur also in profusion in beds of similar and earlier age over a wide area of eastern and south-eastern Australia.

A detailed, illustrated account will follow.

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Origin of the Golden Hamster *Cricetus auratus* as a Laboratory Animal

The golden (Syrian) hamster *Cricetus auratus* is now being bred in scientific institutions in Europe and America and has proved useful for various experimental investigations. Workers from different countries have written to me inquiring about the origin of the golden hamster, which is now widely distributed in many laboratories. Some of the correspondents are interested in using *Cricetus auratus* for genetics, others in the history of this hamster as a laboratory animal.

In 1930 the late Prof. Aharoni, of the Department of Zoology of the Hebrew University, Jerusalem, went on a zoological expedition to Syria (he was particularly interested in the fauna of Antioch). We were engaged on investigations for the Royal Society on Mediterranean kala azar, and the only suitable experimental animal then known was the Chinese hamster, which had to be imported from the Far East and had the additional disadvantage of not breeding in captivity. Stocks could only be replenished by importing, and lengthy experiments in the Middle East were imperilled by epidemics of *Pasteurella* to which this animal is very susceptible.

Prof. Aharoni undertook to bring specimens of *Cricetulus phœus* for our work. In addition to specimens of *Cricetulus phœus* (which were also unsatisfactory because they did not breed in captivity), Prof. Aharoni brought back a litter of eight golden hamsters collected near Aleppo which he reared and presented to the Department of Parasitology in July 1930.

Four of the animals escaped, one female was killed by a male and only three animals—one male and two females (all litter mates)—remained. From these three animals Mr. H. Ben Menahem succeeded in raising litters, and it was quickly established that this species breeds readily in captivity. It was first used for investigations on kala azar in November 1930, and was afterwards found valuable for work on tuberculosis and brucellosis. As soon as this was realized, I decided to distribute the animal as widely as possible and avoid the risk of maintaining a valuable species in one laboratory. (The animal is very susceptible to *S. typhimurium*, and wherever there is a danger of contamination with this *Salmonella*, it is advisable to vaccinate.) I brought specimens to the Collège de France (Prof. Nattan Larrier), to the Medical Research Council and to the Wellcome Bureau of Scientific Research, where Dr. E. Hindle succeeded in breeding them. Shortly before the Second World War I sent animals to India for kala azar research, and the late Prof. I. J. Kligler sent a batch to America. I also sent several batches recently to Egypt. During the War, animals infected with kala azar were sent to the United States at the request of the American Army authorities for experiments on chemotherapy; but these animals were probably not used for breeding.

To the best of my knowledge all the golden hamsters now in use as laboratory animals in Europe and America originate from the above-mentioned three litter mates—one male and two females brought to the Department of Parasitology of the Hebrew University of Jerusalem in July 1930.

It would be interesting to collect more wild specimens from the neighbourhood of Aleppo, and I hope that some worker favourably situated for this purpose will succeed in doing so.

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Determination of Plant Densities

IN surveying plant associations, it is usual to determine the valence by noting the presence or absence of each species in sample areas, and the density by counting the number of individuals of each species in the same, or other, sample areas. Two difficulties are frequently encountered in determining densities by this method, the length of time needed in the field and the intermingling of root systems of individual plants of the same species with consequent indecision as to the exact number present in the sample. The following method has the advantage of requiring one set of observations only, from which valence and density may be determined, and of avoiding counts within the sample areas.

Suppose the species has a density N/A plants per unit area and that a sampling area a is taken t times at random. Then the expected number of plants per trial will be aN/A, and the number y_0 of trials containing no individuals of the species would be expected to be given by the expression

$$y_0 \;=\; t \exp\,(-\,aN/A).$$

$$\text{Whence } \frac{N}{A} \;=\; \frac{1}{a}\,.\,\log_e\,.\,\frac{t}{y_0}.$$

If the number of trials is 50 and the sampling area 0·1 square metre, a graph relating density and y_0 can be drawn and shows a remarkable sensitivity for densities 33 per sq.m. to 3 per sq.m. By increasing the sampling area to 1 sq.m., the density values on the graph are reduced ten times, and we have a sensitive range from 3·3 per sq.m. to 0·3 per sq.m. Much time has been saved in the field and results are reasonably in accord with densities found by the more laborious method.

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June 26.

Metabolism of α : β-Dihydroxy-γ-(2-methylphenoxy)propane ('Myanesin')

IN a recent communication[1], Wyngaarden, Woods and Seevers have shown that 'Myanesin' administered intravenously to dogs appears in the urine mainly in combination with glycuronic acid, while a small amount is excreted without change. We have found that after intravenous administration to humans or rabbits, a portion is oxidized and excreted as α-hydroxy-β-(2-methylphenoxy)propionic acid. The acid may be isolated by acidifying the urine to pH 3, extracting with ether continuously for 24–48 hours, transferring from the ether extract into sodium bicarbonate solution and recovering from the aqueous solution by acidifying and extracting with ether. The ether-soluble product is crystallized first from carbon tetrachloride, then from water and finally from chloroform. The pure acid melts at 146–147° (corr.) (found: C, 61·2; H, 6·1; $C_{10}H_{12}O_4$ requires C, 61·2; H, 6·1 per cent). The acid is not optically active. It is identical with the acid obtained by condensing o-cresol with β-chlorolactic acid (found: C, 61·1; H, 6·1 per cent).

We are indebted to Dr. F. Barnett Mallinson for supplies of urine from patients who had received 'Myanesin'. Our thanks are also due to the directors of the British Drug Houses, Ltd., for permission to publish this note.

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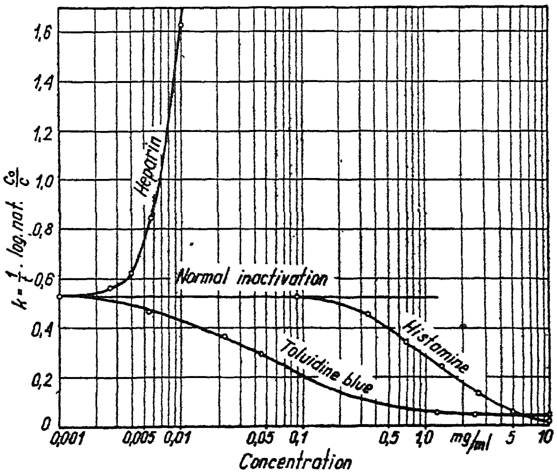
Histamine – Heparin – Thrombin Chain Mechanism

EARLIER experiments of ours have shown that the organism regulates the coagulability of the blood by the inactivation of thrombin[1,2]. Many factors take part in the system causing the thrombin to disappear. We distinguish an adsorption effect and a fermentative inactivation process, and indicate the inactivating process by its reaction velocity factor.

We have worked out a simple and rapid process for investigating the inactivation[3]. We put thrombin of a known activity into the serum under investigation, and after an incubation period of 1, 2, 3, 5 or 10 min., we determine the time in which samples taken from the mixture make the fibrinogen coagulate. As a result of the inactivation we get increasingly longer clotting-times. From the clotting-times we determine their thrombin activity on the basis of an empirical relation, and from the data thus obtained we calculate the reaction velocity factor ($k = 1/t$ log. nat. co/c).



Change in thrombin inactivation reaction-velocity constant under the effect of heparin, toluidine blue and histamine respectively, in rabbit serum

Heparin increases the reaction velocity of the inactivation (see graph). If we bind the heparin with toluidine blue, the velocity of the inactivation diminishes decidedly[4]. We find that histamine, both *in vitro* and *in vivo*, likewise strongly decreases the inactivation, and thereby shifts the clotting capacity of the blood towards coagulation[5]. We have also shown that histamine and heparin bind one another, and have obtained a colour reaction from this[6].

As histamine and heparin are both constantly present in the blood in physiological circumstances, it must be supposed that the normal coagulability of the blood is regulated intravasally by histamine – heparin equilibrium. If this equilibrium shifts towards histamine there is a diminished inactivation and the blood coagulates better, which in certain cases can lead to intravasal fibrin precipitation. But if there is a preponderance of heparin the effect of the inactivating system increases and the blood does not clot so well. These phenomena have been thoroughly observed in pathological[7,8] and experimental[2,9,10] conditions.

Jancsó demonstrated in 1931 that a preliminary condition for the accumulation process of reticulo-endothelial systems was that the colloids to be eliminated from the blood are enclosed in a covering of fibrin, and that this colloid-fibrin complex becomes attached to the endothelium[11]. It was later also found that this occurs also as an effect of histamine[12]; but intermediate links in the chain were lacking to explain how, as an effect of histamine, the fibrin appears in the blood.

But on the basis of the foregoing, the route of the chain mechanism would appear to be briefly that histamine is produced as an effect of the foreign substances introduced into the blood. This binds the heparin and thus inhibits the inactivation of thrombin. This in turn leads to the formation of thrombin and causes intravasal fibrin precipitation. The precipitating fibrin carries off the colloids, which attach themselves to the walls of the endothelium, where their phagocytosis begins. When this phenomenon has taken place, the increasing liberation of heparin compensates for the increased clotting capacity of the blood.

On this basis, the physiological sphere of thrombin must be extended. The function of thrombin is not only to bring about extravasal clotting, but also to fulfil an at least equally important task intravasally, in starting the accumulation in the reticulo-endothelial system as one of the links in the chain of the whole process. This also throws a new light on the problem of thrombosis. Thrombosis occurs when the organism cannot, by increased liberation of heparin, restore to normal the lowered thrombin inactivation required for colloid accumulation.

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[12] Jancsó, M., *Nature*, **158**, 227 (1947).

Hæmoglobin – Methæmoglobin Mixtures

We[1] have recently had an opportunity of confirming, in a case of familial methæmoglobinæmia, the shift to the left in the oxygen dissociation curve of hæmoglobin which Darling and Roughton[2] found in hæmoglobin – methæmoglobin mixtures. They suggest that the shift in the curve may be explained by the existence of intermediate compounds, the affinity of which for oxygen is greater than that of hæmoglobin. On this assumption, the formation of methæmoglobin from hæmoglobin does not take place in a single step; but the four iron atoms of the hæmoglobin molecule may be oxidized separately and successively. If the iron in the hæmoglobin (or oxyhæmoglobin) molecule is represented as $(\text{Fe}^{++})_4$, the iron in the intermediate mixed molecules would be $(\text{Fe}^{+++})(\text{Fe}^{++})_3$, $(\text{Fe}^{+++})_2(\text{Fe}^{++})_2$, $(\text{Fe}^{+++})_3(\text{Fe}^{++})$, and that in methæmoglobin itself $(\text{Fe}^{+++})_4$. As the shift in the dissociation curve is fairly large, it is evident that quite appreciable amounts of the intermediate compounds would be present in methæmoglobin – hæmoglobin mixtures, and might afford spectroscopic evidence of their presence. Apart from its theoretical interest, the question is of some practical importance, for alterations in the absorption spectrum due to this cause would necessitate modifications in the estimation of blood methæmoglobin made by optical methods, for example, that of Evelyn and Malloy[3].

We have looked for spectroscopic evidence for the presence of the intermediate compounds by making differential measurements of the absorption at the red end of the spectrum (where methæmoglobin shows a strong absorption band), comparing optical and physical mixtures of hæmoglobin and methæmoglobin in a Spekker absorptiometer. Using two pairs of closely matched 1-cm. cells, we first filled one member of each pair with a definite volume of methæmoglobin solution containing 1 gm./100 ml. pigment. (The solution was prepared from toluene-laked, washed ox erythrocytes by the action of a small excess of sodium nitrite. It was filtered and exhaustively dialysed at 4° in a rocking dialyser and diluted with *p*H 7·4 phosphate buffer.) The other cells were filled with the same volumes of a separately dialysed, filtered and buffered solution containing 1 gm./100 ml. oxyhæmoglobin. Each oxyhæmoglobin-containing cell was then examined in conjunction with a methæmoglobin cell.

The difference in optical density between the pairs of cells (using 2 mm. Hilger red No. 1 and 2 mm. Calorex filters) was 0·002, representing the difference between the pairs of glass cells. On mixing the contents of one pair of cells, to give a 50 per cent mixture of oxyhæmoglobin and methæmoglobin, the change in absorption was not greater than 0·001, nor was any further change found in readings taken up to 18 hr. after mixing. The total absorption under the conditions used was 0·805, so that the change on mixing was less than 1 in 500 of the total absorption, that is, well within experimental error. Examination of the solutions (diluted 1 in 5) with the Hartridge reversion spectroscope also failed to show any difference between the optical and physical mixtures in the position of the methæmoglobin band in the red part of the spectrum.

If the explanation of Darling and Roughton for the shift in the dissociation curve is correct, it would appear, therefore, that the absorption spectrum of hæmoglobin derivatives is determined not by the molecule as a whole, but by the sub-molecules containing one iron atom.

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Crystal Structure of Nitronium Perchlorate

We have made an X-ray examination of the nitronium perchlorate of Goddard, Hughes and Ingold[1] and find, in agreement with Millen's observations on its Raman spectrum[1], that the crystal structure contains the ions NO_2^+ and ClO_4^-.

The crystals are monoclinic, the unit cell having dimensions $a = 9{\cdot}25$ A., $b = 6{\cdot}99$ A., $c = 7{\cdot}34$ A., with $\beta = 113{\cdot}5°$, and containing four molecules of $NClO_6$. The existence and general arrangement of the ions was discovered from two-dimensional Patterson syntheses of the intensities of X-ray reflexions in the three principal zones, and confirmed by comparison of observed and calculated structure amplitudes; the chlorate and nitronium ions are arranged alternately along twofold axes, in accordance with the space group $C\ 2/c$, the nitrogen and chlorine atoms lying on the twofold axes, with all the oxygens in general positions. By using $\{hkl\}$ structure amplitudes in sectional projections[2] we find that the NO_2^+ ion is linear with N—O $\sim 1{\cdot}1$ A., and the ClO_4^- ion approximately tetrahedral, with Cl—O $\sim 1{\cdot}5$ A. Successive Fourier refinement is now being applied to obtain more accurate values of these bond-lengths.

We are indebted to Prof. C. K. Ingold and Mr. D. R. Goddard for providing crystals specially prepared for this work.

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[1] *Nature*, 158, 480 (1946).

[2] Booth, *Trans. Farad. Soc.*, 41, 434 (1945).

Emissivity of Small Particles in Flames

It is a striking fact that solid (or massive) carbon behaves as a black body, whereas small carbon particles which are responsible for the luminosity of hydrocarbon flames have an absorption coefficient which is strongly dependent on wave-length. This difference is important in the measurement of the colour temperature of luminous flames. It has been shown theoretically by Mie[1] that the absorption coefficient is strongly dependent on wave-length when particles are smaller than a wave-length, an effect which is analogous though not identical with the dependency of scattered light on wave-length.

We have made some optical measurements on a stationary flame of aluminium flakes in air. These experiments differed from the often repeated measurements on photo-flashes since the flame had a greater depth (5–10 cm. diameter). The intensity distribution in the flame was unusual. The radiation consisted of weak AlO bands and a strong continuum which extended from the red far into the ultra-violet regions. The colour temperature was about 3,600° C. It may be shown theoretically that the enthalpy of the exhaust gases permits the temperature of the flame to reach the boiling point of aluminium oxide (Al_2O_3), which is 2,980° ± 60° C., and that nearly all the oxide is vaporized. When we threw an image of the anode of the carbon arc on to the aluminium–air flame, we observed very weak absorption in the visible and increasing absorption towards the violet region. At 3100 A. all light from the arc was absorbed. The emission coefficient, therefore, became very nearly equal to unity in the ultra-violet. By comparing the brightness of the flame at 3100 A. with the brightness of the carbon arc anode, we estimated a brightness temperature which was a little below the calculated (theoretical) temperature. Line reversal measurements (ordinarily a little high on account of the scattering effect) gave a slightly greater value than the calculated temperature.

The close agreement of these results satisfied us that the temperature of the flame was actually the boiling point of aluminium oxide. If we adopt this value, however, an explanation is needed for the high colour-temperature observed, or in other words, for the strong dependency of emissivity on wave-length. We believe that most of the aluminium oxide formed in the flame is initially in the gaseous state. The radiation may therefore originate from gaseous aluminium oxide or other gaseous products (excited thermally or by chemiluminescence), but no continuum of gaseous origin is known which extends so far. Moreover, it is perhaps significant that the conditions are very similar to those in the luminous hydrocarbon flame, where emission is undoubtedly due to small particles.

We suggest, therefore, that small droplets of aluminium oxide are the emitters in the aluminium flame, and that these particles are formed by condensation in the flame. Produced in this way, the particles are finely dispersed and very small. Their temperature is identical with the gas temperature, even if catalytic reactions occur on the surface, because the heat transfer numbers of such particles are extremely high. Some of these particles are no doubt smaller than the wave-length of light (Shechter *et al.*[2] have produced evidence of this), and the absorption and emission characteristics of such particles will behave in the same way as radiant soot. The abnormally high colour-temperature is again attributed to the optical properties of very small particles. Moreover, the colour temperature depends upon the thickness of the optical layer, because the thicker the layer the more the radiation will approach black-body conditions.

Magnesium behaved in a similar manner.

We are indebted to the Chief Scientist, Ministry of Supply, for permission to publish this communication.

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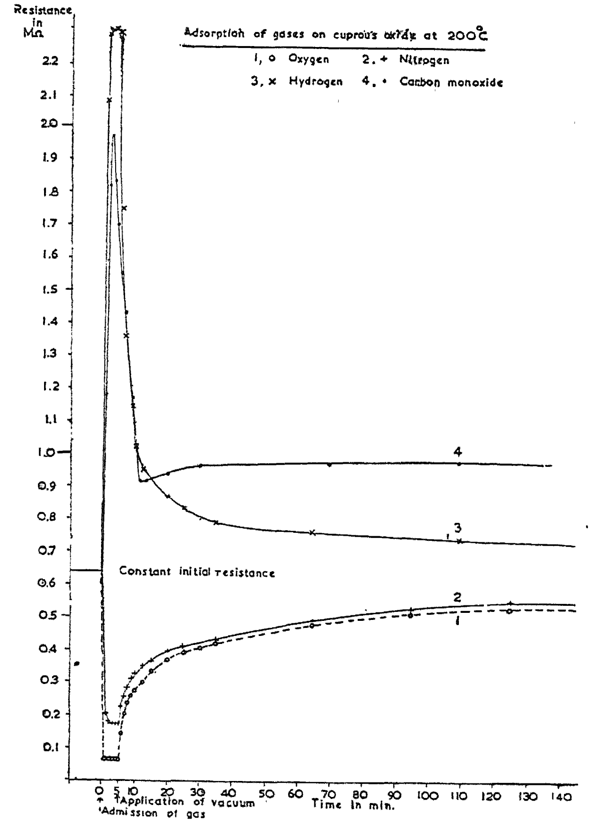
Application of Measurements of Semi-conductivity to Heterogeneous Reactions

In the present investigation pure oxide films are obtained by the oxidation of evaporated metal films. Normal high-vacuum precautions are observed in the use of all-glass, greaseless systems with precise temperature control. The method of investigation which has been developed is based on the semi-conducting properties of these oxide films. Simultaneous pressure and resistivity measurements are made during the adsorption and desorption of various gases on the oxide films over a range of temperatures between 0° and 250° C. While variations in conductivity of bulk semi-conductors on exposure to air have been previously observed and reported (Anderson *et al.*), the effect has not previously been applied to the problem of catalysis. Preliminary investigations which have been carried out on copper oxide films have demonstrated the efficiency in obtaining reproducibility of the film during periodic oxidation and reduction.

On oxidation of the copper film during the initial period of oxidation the resistance measurements are effectively those of the residual copper layer, being of the order of one ohm in typical cases. This period is characterized by a parabolic uptake of oxygen. At the end of this period, which occupies several hours at 200° C., there is an extremely rapid change in resistance over a period of a few minutes before stabilizing at a high value, 350 k.ohm in a representative case. After this there is a slow exponential change in resistance to a final value corresponding to that of pure cupric oxide obtained after approximately 25,000 min. at 200° C. In this final state the film shows no increase in resistance on sustained pumping at 10^{-7} mm. mercury pressure.

On hydrogen reduction there is an induction period after which the resistance increases to a very high maximum value, corresponding to the formation of cuprous oxide in the non-conducting state. Further reduction gives a rapid fall in resistance to a value of about 50 k.ohms in a typical case, at which point erratic readings are obtained, fluctuating between that value and a few hundred ohms. This continues for a period of about 15 min. and corresponds to the embrittlement phenomenon reported by Garner and Stone[1], probably due to the escape of water from the film. After this characteristic period the resistance falls exponentially until after about 30,000 min. the original resistance of the copper film is obtained.

For studying the effects of adsorbed gases, the films were employed in the semi-conducting region corresponding to a stoichiometric ratio lying between cuprous oxide and cupric oxide. When the film had been oxidized to the required composition it was subjected to prolonged pumping at 10^{-7} mm. mercury pressure, during which there was an increase in resistance to a constant value, 650 k.ohms in a typical case. The value of this maximum corresponds very closely to the final value of the pure cupric oxide film and did not vary significantly over a wide range of composition. This corresponds with the observations of Anderson and others on the effect of the evacuation of bulk semi-conductors.



Quantitative and qualitative information has been obtained concerning the effect of the adsorption of oxygen, nitrogen, hydrogen and carbon monoxide on the semi-conducting films in this condition. Admissions of oxygen at a series of temperatures and at pressures varying between 10^{-3} mm. and 0·3 mm. mercury pressure have shown that there is an immediate fall in resistance of great magnitude taking place within the first five seconds, followed by a slightly slower change over a few minutes (curves 1 and 2). The films are only exposed to the oxygen for a few minutes and are then subject to hard vacuum, 10^{-7} mm. pressure being attained in approximately 15 sec. During evacuation there is an increase in resistance, a very rapid second-order change at first, but becoming exponential after about 30 min. The final value obtained after about 2,500 min. is, for temperatures above 200° C., identical with the initial value; but below this temperature very protracted pumping fails to re-establish the original equilibrium condition. All curves show a very high degree of reproducibility.

The effect of nitrogen is qualitatively the same as for oxygen, while helium, which has no effect alone, modifies the effect of both adsorption and desorption by slowing down both processes to a marked degree.

On the adsorption of carbon monoxide or hydrogen the resistance increases rapidly to a very high value (curves 3 and 4). In the case of hydrogen the process is reversible, but in the case of carbon monoxide the removal of the gas, possibly as carbon dioxide, is complicated by the apparent immediate reduction and sintering of the surface, which completely alters the film characteristics. After adsorption of carbon monoxide it is possible to return the film to its standard state only by oxidizing the film completely, reducing to copper and reoxidizing. Only after this drastic processing does the film reproduce earlier results. This effect has been reported by Garner and Stone on bulk copper oxide.

The investigation is being extended to a range of temperatures enabling temperature coefficients of the various processes to be established, and to various other oxides. Precision measurements of gas adsorbed and desorbed are being introduced, and the significance of substrate is being investigated.

Although too early to embark on any rigid theoretical consideration of the significance of the results, it is clear that providing the general picture of semi-conduction as given by Mott is accepted, then these measurements must yield direct information of the nature of the catalytic processes occurring, as related to adsorbed gases on semiconducting oxide catalysts.

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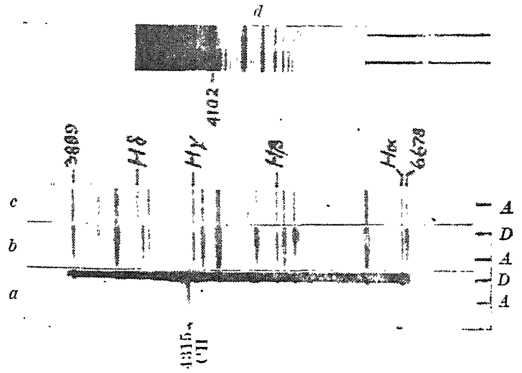
Afterglow of the Balmer Spectrum of Hydrogen

In a paper published during the War the late Lord Rayleigh reported some new experiments about the hydrogen spectrum, indicating a duration of Balmer lines of more than 10^{-5} sec., which is roughly one thousand times greater than the values calculated from quantum mechanics and experimental results with positive rays. The method consists in producing a strong luminosity induced by a powerful condenser discharge in an electrodeless glass tube. Each discharge produces a jet of luminosity, squirting out of the electric field by thermal expansion into a side tube where the decay of the Balmer lines is observed and measured[1].

Lord Rayleigh did not attempt any explanation of this result and apparent discrepancy. Jablonski has remarked that the mean duration of lines is not always identical with the mean life in initial states of corresponding transitions. After having considered the various mechanisms which can produce atoms in the upper level, he thinks that the persistence of the luminosity results from the radiative recombination of atomic hydrogen ions[2].

Born, Fürth and Ladenburg[3] prefer to believe that Lord Rayleigh's experiments can be understood on the basis of the known relatively long life of free hydrogen atoms and their re-excitation "by radiation and, especially, by the diffusing electrons and positive ions". The rise of the relative intensity of the blue-green H_β lines (4861 A.) observed by Lord Rayleigh with decreasing luminosity is ascribed to the sensitivity of the eye, which has a maximum in the green part of the spectrum.

In view of making a choice between the two above interpretations, new experiments were performed on the hydrogen afterglow. The experimental arrangement is the same as already described[4]. It permits a careful separation of the light of the discharge from that of the afterglow one. The excitation energy used in our experiments is weak and is not sufficient to show the persistence of the luminosity in pure hydrogen. But when this element is diluted in neon or helium a strong afterglow can be observed. In the case of helium, traces of hydrogen almost always present are sufficient to give the phenomenon. Other impurities like CO and CH destroy the afterglow: the spectrum *a* shows that only the band 4315 of CH persists in this case. The impurities are eliminated either by producing a powerful discharge between two magnesium electrodes or by immersing the discharge vessel in liquid nitrogen.



D, discharge; *A*, afterglow

Spectrum *b* shows the modification of the emission of helium containing traces of hydrogen when the discharge is cut off. The Balmer lines suffer less variations than He I lines, and the relative intensity of H I increases with time. This later variation can be seen easily by comparing the spectrum at the beginning of the afterglow with spectrum *c* emitted 10^{-3} sec. after breaking the discharge. The duration of the lines increases with the quantum number *n* and the intensity of distribution of the Balmer spectrum varies with time (compare spectra *b* and *c*).

By measuring the decay of luminosity with the time, we have evaluated the duration of the H_γ line at 10^{-4} sec. after breaking the discharge.

It is possible to show that the emission in question follows the capture of electrons by ions by studying the afterglow at the limit of the Balmer series. The discharge and the afterglow were photographed in the ultra-violet region with an Arnulf–Lyot spectrograph. The results are illustrated by the spectrum *d*. In the afterglow, the hydrogen spectrum is extended further than in the discharge; at the same time, the higher level lines of He I grow in intensity.

The above results, although they do not allow a direct comparison with Lord Rayleigh's experiments, show that hydrogen atoms can radiate the whole Balmer series in afterglow. The persistence of the lines at the limit of the series seems to be conclusively in favour of an emission by radiative recombination between ions and electrons.

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Decay Scheme of ^{181}Hf

In continuation of our previous analysis of the decay scheme of ^{181}Hf [1], we have carried the work further with higher resolving power and using a spectrometer with a thin Geiger–Müller window. We have also carried out delayed coincidence measurements to study the metastable state reported by De Benedetti and McGowan[2]. We have attempted to eliminate various possible decay schemes which have been proposed[1-3], in favour of one to be discussed here.

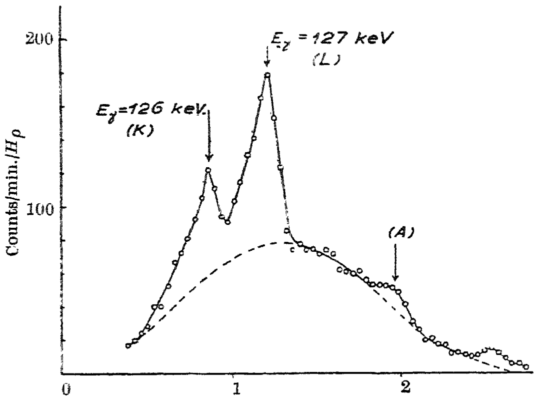

Fig. 1. The β-spectrum of ^{181}Hf (resolving power 4 per cent)

The measurements of the β-spectrum were repeated with the same spectrometer as formerly[1]. The resolving power was, however, increased to 4 per cent and the window thickness reduced to ~0·5 mgm./cm.^{2}. The β-spectrum is shown in Fig. 1. It will be seen that the conversion line (A) of the 342-keV. γ-quantum which could not be discerned in the previous measurement now appears distinctly. Otherwise the two spectra are in good agreement.

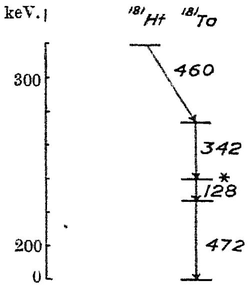

Fig. 2. Decay scheme of ^{181}Hf (all energy values given in keV.)

Delayed γγ-coincidence measurements were carried out in our standard arrangement[1], where a time-delay of ~ 10 μsec. was introduced in one channel. The sample was enclosed in a lead shield 1 mm. thick. The soft radiations (the unconverted 128-keV. γ-quantum and the corresponding X-radiation) were thus practically cut off. Under these conditions, a γγ-coincidence effect amounting to $(k_{\gamma\gamma}/n_\gamma) \times 10^3 = 7 \times 10^{-3}$ was found. This effect is about half the chance coincidence effect. The experiments were repeated many times, and the chance coincidence effect was checked, after each measurement, by ^{60}Co of the same counting-rate in the tubes. These results support the decay scheme given in our previous paper[1] and reproduced here in Fig. 2. The magnitude of the coincidence-rate is in agreement with that computed (from the geometry of the arrangement, the efficiency of the γ-tubes, the half-life of the metastable state and the delay and resolving times of the amplifier).

According to the conclusions of De Benedetti and McGowan[2] the metastable state should follow directly the β-transmission. This is not in agreement with our suggestion. The reason why they have not found any effect of the γ-ray which precedes the metastable state may be due to the fact that its energy is less than the one which follows the metastable state.

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Errors of Treatment Comparisons when Observations are Missing

IN a randomized block experiment with J blocks and K treatments, for which σ^2 is the variance of the random component of the observations and for which no observations are missing, the estimated difference of the means of two treatments has variance $2\sigma^2/J$. For the case where some observations are missing, Yates[1] has shown how the missing values may be estimated, a valid analysis of variance carried out, and an unbiased estimate of the difference of means of two treatments obtained. He has given the variance of this estimate for the case of only one missing observation, and has suggested an approximation for use in other cases which may be expressed as follows.

If J_A observations are present for treatment A, and j_A of these are in blocks which contain no observation for treatment B, and if J_B observations are present for treatment B, and j_B of these are in blocks which contain no observation for treatment A, then the variance of the estimate of the difference of means of A and B is $\theta_{AB}\sigma^2$, where

$$\theta_{AB} = \frac{1}{J_A - \tfrac{1}{2}j_A} + \frac{1}{J_B - \tfrac{1}{2}j_B}, \text{ approximately.}$$

I have derived exact formulæ for θ_{AB} for all cases where not more than three observations are missing, and have compared the exact and approximate values for a wide range of values of J and K. The agreement is reasonably good when K is small but poor when K is large. The formulæ suggest that a closer approximation would be given by

$$\theta_{AB} = \frac{1}{J_A - \dfrac{1}{K-1}j_A} + \frac{1}{J_B - \dfrac{1}{K-1}j_B},$$

and this is confirmed by numerical calculation. If not more than three observations are missing and J and K are both greater than 3, the error of the approximation only exceeds 4 per cent in a very few cases. These all occur either where there are three missing observations and $J = K = 4$, or where practically all observations of one treatment or one block are missing. In most cases the error is very much smaller than this.

In practical applications an analysis of variance would first be carried out to test if there were any significant differences between treatments. If so, any pair could be tested and would be judged to differ significantly if the difference of their means exceeded $t\sqrt{\theta}\,s$, where s^2 was the error mean square with n degrees of freedom, and t was the appropriate percentage point of the t-distribution with n degrees of freedom.

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[1] Yates, F., *Emp. J. Exp. Agric.*, 1, 129 (1933).

Development of Spark Discharges

IN a recent communication[1] concerning the mechanism of growth of the leader strokes preceding spark discharges, Allibone has stated that the leader stroke develops behind a voluminous corona discharge and that the concentrated bright streamer, which is readily photographed, is in the nature of a 'core' to this corona. The same view has been expressed by ourselves on various occasions and in earlier reports[2], and not only have we succeeded in demonstrating beyond doubt the existence of this diffuse corona discharge forming the head of the leader stroke, but we have also been making extensive investigations of its characteristics during the past eighteen months.

From consideration of the rotating camera records[3], which show the existence of diffuse corona discharges in association with the brighter filamentary streamers, it became clear to us some time ago that the photographic methods of observing the development of leader strokes have certain limitations and require to be supplemented by other techniques[4]. Allibone has referred to experiments made with Lichtenberg figures, but in such measurements, where stationary recording systems are used, it is difficult to determine the sequence of the processes observed, particularly because of the diffuse nature of the discharge. Similar difficulties occur in the interpretation of rotating camera photographs, where a distinction between spatial and temporal displacements is confused when the photographed object is diffuse.

Because of the various limitations of the photographic measurements, we decided to study the growth of leader strokes by arranging for the light emission from the discharge to fall on the sensitive cathode of a photomultiplier, the output from which is amplified and is reproduced on an oscillograph screen[5]. With this technique, a very high resolution in time is possible, of less than 10^{-7} sec., and the sensitivity to light is greater than that of a photographic emulsion. Further, the intensity of the light can be determined more accurately than in the photographic method, where there is a failure in the reciprocity law when light pulses of short duration are being recorded.

With this technique we have observed the corona discharge occurring in a discharge gap between a positive point and a negative plane, for impulse voltages below that required to cause breakdown. Under these conditions, for a 50-cm. gap in air at atmospheric pressure, the corona discharge produces a light pulse as shown in the oscillogram of Fig. 1. The corresponding current pulse in the gap is of the same shape. Both pulses rise to their peak amplitude in a time 5×10^{-8} sec. and decline to a small value after 4×10^{-7} sec. By the use of slits placed between the gap and the photomultiplier the light distribution with corona has been examined, and we have found that the light is emitted from a roughly hemispherical volume, with the positive point at the centre of the plane face of the hemisphere, which is parallel to the negative plane, and with the curved face directed towards the plane. The light intensity decays continuously with distance from the point.

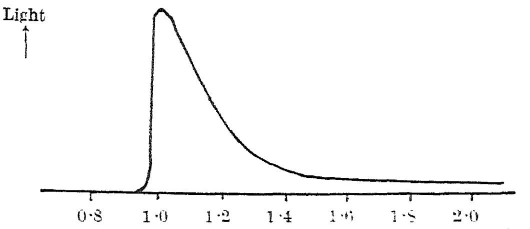

Fig. 1

When the impulse voltage applied to the gap is raised to the breakdown value, or to higher values, a leader stroke develops from the point and initiates a spark. The growth of this leader stroke has been studied by placing between the gap and the photomultiplier an opaque screen containing a slit, the position of which can be altered, so that changes of light in different parts of the gap can be recorded. As the leader stroke passes the slit it produces an increase in the light reaching the photomultiplier through the slit, and consequently a deflexion is produced on the oscillograph screen. The occurrence of the main stroke also causes a deflexion, and from measurements of the amplitude of the various deflexions and the time intervals, both the distribution of light in the leader stroke and its speed of growth can be determined. A typical oscillogram is reproduced in Fig. 2. The discharge commences as an impulse corona which is too small to appear on this oscillogram. Afterwards the light intensity passing through the slit increases gradually as shown to a peak which corresponds to the passage of the 'core' of the leader stroke across the slit. The light then decreases rapidly to a small value and increases again very suddenly when the main stroke occurs. From this evidence it is clear that the leader stroke does not consist of a point source, as this would give a sharp light pulse of duration about 10^{-7} sec., but that it is formed by a diffuse discharge which increases in intensity to a central 'core'. The distribution of the light in the leader stroke, and its size, is generally similar in appearance to the impulse corona mentioned above. Emission of light can be detected up to a distance of the order of 10 cm. ahead of the central 'core'.

Besides the measurements of the light distribution, in space and time, the speed of the leader stroke at different stages in its growth across the gap has been determined, and the current flowing in the leader stroke has been recorded oscillographically. The investigations have been made in air, at atmospheric

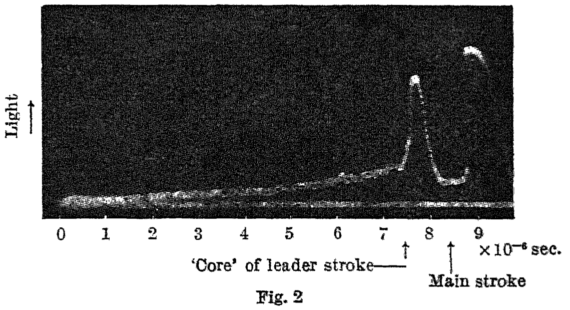

Fig. 2

and reduced pressures, and also in several other gases. A full account of these investigations will be published elsewhere.

We should like to acknowledge the financial support given to this work by the British Electrical and Allied Industries Research Association.

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[1] Allibone, *Nature*, 161, 970 (1948).

[2] Saxe and Meek, Brit. Elect. and Allied Ind. Res. Assoc. Report Ref. L/T.183 (1947); Report Ref. L/T.188 (1947) (completed and revised accounts are in process of issue).

[3] Allibone and Meek, *Proc. Roy. Soc.*, 166, 97 (1938); 169, 246 (1938).

[4] Meek and Craggs, *Nature*, 152, 538 (1943).

[5] Prime and Saxe, *J. Inst. Elect. Eng.* (in the press).

The object of my recent experiments[1] was to bring out photographically what we have known for many years. With an adequate background of visual observation of spark formation, there is no difficulty in determining in general terms the sequence of occurrence of the different kinds of discharge. As the voltage applied to a point/plane gap is increased, the corona extending therefrom increases (I would not have described the volume of discharge as hemispherical in shape; Fig. 5 in ref. 2 is a very typical shape for such a discharge), and near breakdown the concentrated bright streamers or leader strokes first become obvious extending over part of the gap as described in my communication in *Nature*[1]. The technique of chopping the spark with another spark gap in parallel enables the development of the leader stroke to be followed.

Prof. Meek and Mr. Saxe's technique will be invaluable in providing quantitative data on the corona and leader stroke currents and the light emitted by these discharges; but the facts they describe are well known though not well supported by photographs. The simple Lichtenberg figure technique which I have described gives the best photographic record of the leader stroke developing out of the corona discharge; it might even be more sensitive than the photomultiplier, because Fig. 2 of ref. 2 shows unmistakable evidence of corona one metre ahead of the leader stroke, whereas the multiplier has recorded light emission only 10 cm. ahead of the central core or leader stroke.

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[1] *Nature*, 161, 970 (1948).

[2] *J. Inst. Elect. Eng.*, 82, 513 (1928).

Internal Pair Conversion

When a γ-quantum, emitted from the nucleus of a radioactive atom, is absorbed by the same atomic system, an ordinary electron and a positron may be liberated if the energy of the γ-quantum is greater than $2mc^2$. This effect has been calculated by Jaeger and Hulme[1] on the assumption that the γ-ray is electric dipole or quadrupole radiation. I have performed the corresponding calculation for the magnetic dipole radiation and the element $Z = 84$. In calculating the coefficient, Dirac's exact wave equation of the electron is used and the process is interpreted as the transition of an ordinary electron from a negative energy to a positive energy state. The results are given in the accompanying table, where the energies are expressed in units of mc^2 and N is the number of positrons (which is, of course, equal to the number of the pairs created) per unit energy range.

Energy distribution of the electron pairs

$h\nu = 2\cdot62$ MeV.	$\frac{E_+ - 1}{h\nu - 2}$	0·159	0·383	0·612	0·840
	$N(h\nu - 2)10^4$	7·10	9·70	14·9	26·2
$h\nu = 8\cdot00$ MeV.	$\frac{E_+ - 1}{h\nu - 2}$	0·073	0·366	0·635	0·926
	$N(h\nu - 2)10^4$	31·3	48·8	77·6	58·7

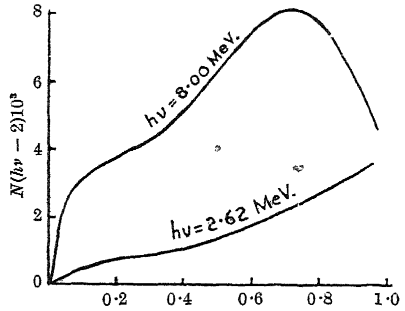

Fig. 1

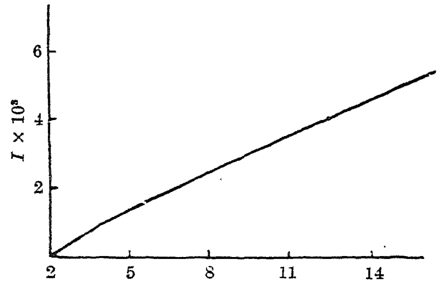

Fig. 2

In Fig. 1, $N(h\nu - 2)$ is plotted against $(E_+ - 1)/(h\nu - 2)$. The marked difference in the average energy of the electrons and positrons is due to the Coulomb forces acting on the two particles. Moreover, the curve, for $h\nu = 8\cdot00$ MeV., shows a maximum near the highest positron energy, as would be expected. By integrating over these curves, the coefficients of the internal pair conversion of the γ-rays are deduced. The results are:

$$I = 1\cdot5 \times 10^{-3} \text{ for } h\nu = 2\cdot62 \text{ MeV.},$$
$$\text{and } I \doteq 5\cdot6 \times 10^{-3} \text{ for } h\nu = 8\cdot00 \text{ MeV.}$$

If we plot I against $h\nu$ (Fig. 2), it is found that a straight line connecting these two points nearly passes through the point ($I = 0$, $h\nu = 2mc^2$).

In conclusion, I want to express my gratitude to Mrs. B. Jeffreys and Dr. N. Kemmer for their valuable discussions.

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June 22.

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[1] *Proc. Roy. Soc.*, A, 148, 708 (1935).

ISOLATION FROM ARGEMONE OIL OF DIHYDROSANGUINARINE AND SANGUINARINE: TOXICITY OF SANGUINARINE

By S. N. SARKAR
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ARGEMONE oil has received considerable attention during recent years on account of its alleged etiological role in epidemic dropsy[1–4]. I pointed out[5] certain anomalies of the mustard oil – argemone oil theory of epidemic dropsy and stressed the fact that a definite solution of the problem could only be arrived at by isolating the active principle from argemone oil and the suspected mustard oil, and then showing that these are chemically identical and possess similar toxic properties. Lal *et al.*[2] could not produce any satisfactory evidence on this aspect of the problem.

In a report of some preliminary work done, Sarkar and Rahman[6] stated that it was possible to precipitate the nitrogenous bases present in argemone oil as crystalline picrate, and from the crude picrate at least two fractions could be separated each of which when converted into the hydrochloride proved toxic to rats by oral administration, causing heavy mortalities. With the view of clearing up some of the important points, a detailed investigation was undertaken by me under the direction of Prof. R. A. Peters, and the relevant findings are reported here.

The main alkaloid of argemone oil has been purified by chromatographic analysis on an alumina column followed by crystallization from alcohol – benzene mixture. The purified compound (I), m.p. 190–91°, agreed in formula and properties with dihydrosanguinarine (found: C, 72·11: H, 4·54; N, 4·22; $C_{20}H_{15}O_4N$ requires C, 72·07; H, 4·51; N, 4·21 per cent). It is clear, therefore, that the formula $C_{19}H_{15}O_4N$ proposed for this compound by Mukherji, Lal and Mathur[7] is not correct. An authentic sample of dihydrosanguinarine obtained from the laboratory of the late Prof. Späth, when further purified by the present procedure, melted at 190–91°, and the mixed melting point with compound (I) did not show any depression.

Compound (I) could be readily oxidized by ferric chloride in presence of hydrochloric acid giving beautiful orange-red crystals of sanguinarine hydrochloride (II). This compound is identical with the compound obtained before in the ferric chloride test for the detection of argemone oil developed by me[8]. By the identification of the compound, the theoretical basis of the test is provided. Compound (II) was easily converted into the pseudo-cyanide, m.p. 238–39° (decomp.), and this could be reconverted into the original hydrochloride. The authentic sample of dihydrosanguinarine also behaved in the same way with ferric chloride.

Further confirmation came from the oxidation of compound (II) to oxysanguinarine, isolation of a zinc-dust distillation product, m.p. 135–135·5°, giving the fluorescence test of Graebe[9] and agreeing with the formula of α-naphthaphenanthridine, and also from the transformation of (I) into 3.4.6.7-tetramethoxy-11.12-dihydro-N-methyl-α-naphthaphenanthridine, m.p. 183–85°, and giving a mixed melting point, 182–84°, with an authentic sample, m.p. 181–83°.

Sanguinarine has been isolated from argemone oil by chromatographic analysis of the oil on a silica column, and also from the crude precipitate obtained by passing dry hydrogen chloride into an ethereal solution of the oil; the amount of sanguinarine hydrochloride obtained by the latter procedure is 0·44 mgm./c.c. of oil. In this sample of oil, dihydrosanguinarine accounted for about 87 per cent and sanguinarine for about 5 per cent of the total alkaloids present.

When sanguinarine hydrochloride was injected intraperitoneally to albino rats in a dose of 2 mgm./100 gm. body-weight, there was 100 per cent mortality. In contrast to this, dihydrosanguinarine at about two and a half times this dose, or oxysanguinarine at about four times this dose, did not kill any of the rats injected. Sanguinarine hydrochloride was also toxic when fed by mouth, and by following a suitable procedure, young albino rats (40–96 gm.) could be killed usually within a week by administering 1 mgm. of the poison daily.

In further studies of the toxic effects of sanguinarine, the eyes of two albino rats about to die from a lethal intraperitoneal dose of the hydrochloride were removed by Dr. Pirie and Dr. Jackson, and sectioned. The sections, compared with those from normal eyes, showed that there was great congestion of the capillaries of the iris, choroid and retina.

Sanguinarine hydrochloride is toxic to some enzyme systems also. It has been found, for example, that it can inhibit the oxidation of pyruvate, lactate and succinate by pigeon brain preparations. In fact, the effect on pyruvate oxidation was very marked, and with the pigeon brain homogenates used in this laboratory, about 30–35 per cent inhibition of the total oxygen uptake in presence of added pyruvate was noticed with 0·041 mM concentration of the poison. Addition of cocarboxylase could not prevent this inhibition.

The observed inhibition of pyruvate oxidation strongly suggests the possibility that there should be accumulation of pyruvate in the blood of persons suffering from dropsy due to argemone oil poisoning. This agrees very well with an observation of Wilson and Ghosh[10] that there was a significant rise in the bisulphite-binding capacity of the blood in epidemic dropsy cases. In a preliminary experiment carried out here, a definite rise in blood pyruvate has been noticed in rats after a heavy dose of sanguinarine hydrochloride intraperitoneally.

The inhibitory effect of sanguinarine hydrochloride on some —SH enzymes suggested the possibility that it was probably combining in some way with the essential —SH groups. This was confirmed by the observation that when B.A.L. or monothioethylene glycol was treated with an excess of sanguinarine hydrochloride at *p*H 7·4, there was a precipitate containing sulphur and the filtered solution gave negative nitroprusside test. It has not been possible as yet to purify these compounds; but analysis of a nearly pure compound with monothioethylene glycol confirms the presence of sulphur in the compound and indicates also that very probably one molecule of the base is combining with one molecule of thiol.

In vitro experiments with the pigeon brain homogenates showed that if mixed before, 50 μgm. of B.A.L. could completely protect the pyruvate oxidase system from the toxic effect of 100 μgm. of sanguinarine hydrochloride—even 20 μgm. of B.A.L. could afford about 70 per cent protection. However, B.A.L. could not reactivate the already poisoned enzyme.

These results were confirmed by *in vivo* experiments. When albino rats were injected with an excess of B.A.L. (intramuscularly) 15–20 minutes before the administration of a lethal dose of the poison (2 mgm./100 gm., intraperitoneally), there was almost complete protection and about 85 per cent of the treated rats survived.

Since B.A.L. will not reverse the *in vitro* damage to enzymes, it is unlikely to reverse any toxic effects already established by sanguinarine, but it might be useful in preventing further damage due to any unreacted poison.

The poisonous nature of sanguinarine was known before and its pharmacological effects were studied by Meyer[11].

A detailed account of the work will be published at an early date.

My grateful thanks are due to Prof. R. A. Peters for his continued interest and help and for the facilities provided. I am indebted to Dr. A. Pirie and Dr. C. R. S. Jackson for examining the eyes of some of the experimental rats, to Prof. L. Ebert for samples of dihydrosanguinarine, sanguinarine nitrate and the tetramethoxy compound, to Dr. L. A. Stocken for the sample of B.A.L. and to Prof. S. N. Bose for the argemone oil. My thanks are also due to the Government of India for a research grant, and to the Carnegie Grants Committee of the University of Oxford for some financial help.

[1] Sarkar, S. L., *Ind. Med. Gaz.*, **61**, 62 (1926).

[2] Lal *et al.*, *Ind. J. Med. Res.*, **27**, 207 (1939); **28**, 163 (1940); **29**, 157, 167, 813, 839 (1941).

[3] Chopra *et al.*, *Ind. Med. Gaz.*, **74**, 193 (1939).

[4] Pasricha *et al.*, *Ind. J. Med. Res.*, **27**, 947 (1939).

[5] Sarkar, *Ann. Biochem. Exp. Med.*, **1**, 59, 204 (1941).

[6] Sarkar and Rahman, *Curr. Sci.*, **14**, 196, 200 (1945).

[7] Mukherji *et al.*, *Ind. J. Med. Res.*, **29**, 361 (1941).

[8] Sarkar, *Ann. Biochem. Exp. Med.*, **1**, 271 (1941); **2**, 101 (1941).

[9] Graebe, *Annalen*, **335**, 127 (1904).

[10] Wilson and Ghosh, *Ind. Med. Gaz.*, **72**, 147 (1937).

[11] Meyer, *Arch. Exp. Path. Pharm.*, 397 (1892).

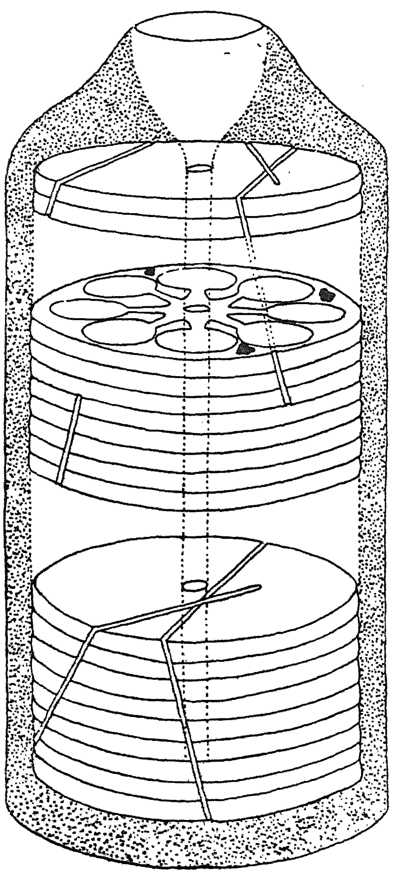
THE TECHNIQUE OF CASTING COINS IN ANCIENT INDIA

THE chance discovery by Prof. Birbal Sahni at Rohtak, some forty miles west-north-west of Delhi, in 1936, of a clay mould for the casting of a coin, later led to the discovery of many thousands of fragments of similar moulds. The bronze coin, about 19 mm. in diameter, of the Yaudheya series, has been dated about 100 B.C. From the very large amount of material available, Prof. Sahni has been able to work out in the greatest detail the entire story of the casting technique employed[1].

The accompanying figure illustrates the manner in which the mould was constructed. A pouring basin at the top leads to a central vertical runner, 7 mm. in diameter, from which, at successive levels, eight radial runners communicate with moulds for the same number of coins. The disks containing these moulds were 87 mm. in diameter and were built up into a pile, perhaps a foot or so in height. Around this there was a jacket of clay admixed with fragments of unhusked grain. When the mould was complete it was heated up to a surface temperature of the order of 600°–650° C., as a result of which the organic material was charred, leaving the jacket in a porous condition through which the gases could escape.

There can be little doubt that the moulding technique was carried out in the following manner. Around a wooden baseboard of the same diameter as the disks, and with a central peg 7 mm. thick fixed in the centre, a cylindrical container was placed, and a slab of plastic clay, sufficient for one disk, introduced. On this the side runners were first moulded from an 8-spoked metal pattern about 1½ mm. thick. At the ends of the spokes the coin moulds were pressed into the clay, a very large number of such patterns being employed, and any obstruction between the individual runners and the mould being removed. This disk was then dusted with a parting powder, such, for example, as wood-ash, and a second one prepared on top. In order to ensure exact register of the two surfaces of the disks, small irregular fragments of stone or brick were introduced into the lower disk while still plastic, producing a corresponding depression in the overlying surface. In this way a set of up to a dozen disks was produced, the upper and lower surfaces of each complete set being blank. On the removal of the surrounding cylinder, an oblique groove was marked across the upper surface of the disks and obliquely down the side. In most cases two such grooves are marked and the re-assembly of the disks (after drying) in their correct order thus facilitated. After air drying, the disks were re-assembled and a series of sets piled one on another to produce a mould of appropriate size.

This, after being covered with the jacket, was baked in some sort of furnace and the casting carried out while the mould was still hot, probably while still in the fire, with the pouring basin alone exposed.



When cold the mould was broken open and the coins broken away from the runners. The author suggests that on one of the two opposing faces an obstruction was often deliberately left between the side runner and the coin mould, providing a small notch which enabled the coin the more easily to be detached.

The question as to whether this coin foundry was legitimate or not is discussed by the author, who concludes—possibly on somewhat scanty evidence—that these moulds were not, in fact, the product of a forger. Whether this be so or not is quite immaterial, however, from the point of view of the most interesting information provided regarding a technique employed at this very early date. A comparison is also made with other conjectured reconstructions of Indian and other coin moulds of different dates and localities. In the latter cases, however, more material is needed to settle the details of the process with the same certainty which has been possible in the case of the Rohtak procedure. To the metallurgist and numismatist alike, this contribution is one of outstanding interest.

F. C. THOMPSON

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[1] "Memoirs of the Numismatic Society of India", No. 1, Bombay, 1945.

ATOMIC ENERGY EXHIBITION: THE ATOM TRAIN

AFTER a tour lasting six and a half months, during which the Atomic Energy Exhibition, organised by the Atomic Scientists' Association, visited twenty-five of the main centres in England, Scotland and Wales, the exhibition came to a close on May 28. Efforts to secure an extension in Great Britain failed; but the exhibition will continue its existence abroad. The Council of the Atomic Scientists' Association, as well as the Ministry of Supply and other owners of equipment, have agreed to lend the exhibits to the United Nations Educational, Scientific and Cultural Organisation and the Lebanese Government for incorporation in an exhibition at the Unesco Conference in Beirut in October. Later it will probably tour several countries in the Middle East and, possibly, various European countries. Although the administration of the tour is left to Unesco, the Atomic Scientists' Association will be closely connected with it, and the atomic energy part of the exhibition will be known as that of the British Atomic Scientists' Association.

In Great Britain the exhibition was an outstanding success and excelled all hopes. It was visited by more than 146,000 people, making an average daily attendance of 1,000, which is 80 per cent of the maximum capacity. In many places people were queueing up for several hours. 85 per cent of the visitors came especially to see the exhibition, many of them making long trips for this purpose.

The reaction of the public was learnt from the answers of more than 1,100 people to a questionnaire handed out to a random sample of visitors. They show that the visitors represented a fair cross-section of the British public as regards occupations, with a slight bias in favour of the intellectual classes. 95 per cent of the public thought it worth while coming, and 91 per cent said that they had learnt something from the exhibition. The most interesting parts were found to be the counters and models (32 per cent) and the peaceful uses (24 per cent); the atom bomb section was the main item of interest for only 7 per cent. Quite a large number of people expressed surprise that atomic energy could be used for constructive purposes as well. The main criticism of the exhibition was that it was not big enough and too crowded.

The guide book to the exhibition sold extremely well. Altogether more than 50,000 copies were sold or presented, making it the most popular and widespread publication on atomic energy.

The performance of the technical equipment, most of which was very delicate and tricky to operate, was extremely satisfying. Some of the experiments were demonstrated publicly for the first time and only a few years ago could not have been made to work reliably even with the best care in the laboratory. Here they were subjected to the most adverse conditions, to the movement of the train on a 1,900-mile journey, to differences of temperature ranging from 30° to 100° F., to a wide range of voltages in the various places and, above all, to the heavy hands of about 130,000 adults and 16,000 inquisitive children.

Not only has the equipment withstood the test magnificently, but also it has beaten all records for endurance of this type of apparatus. The scaling units are supposed to have a life-time of 200 hours, and yet during the 1,600 hours of operation of five scaling units, only one valve had to be replaced. Throughout the whole tour, each Geiger counter had to be replaced only once. The total time when the exhibits were out of commission amounted to less than 1 per cent and the total expenditure on maintenance of equipment, including replacement of films, fluorescent tubes, etc., was less than £50.

All this is evidence of the good quality and high-class workmanship of the British firms who manufactured it; it is also a tribute to the technical staff who looked so well after the maintenance of the equipment.

The Atomic Energy Weeks, which were organised in conjunction with the exhibition, were also very successful and the lectures and film shows were well attended.

Summing up, it can be concluded that the exhibition achieved its main object—that of educating an appreciable fraction of the British public in matters of atomic energy.

ROTHAMSTED EXPERIMENTAL STATION

REPORT FOR 1946

THE return to peace-time activities at Rothamsted Experimental Station enabled much of the fundamental and long-range work to be resumed, and the report for 1946 now issued includes a short account of such investigations, as well as of new work undertaken by the various departments. There are departments of physics, chemistry, soil microbiology, botany, crop physiology, statistics, plant pathology, biochemistry, entomology, insecticides and fungicides, and one for the study of bees. This list of departments indicates the very wide scope of the work at Rothamsted, and it is impossible not to be impressed by the advantages that must accrue from the ready contacts that are possible between the workers in the various sections. The experimental farm, together with that of Woburn, one on heavy and the other on light soil, offers every facility to the research worker, and the work of the Statistical Department enables field-work to be carried out with the maximum of effect. Field-work is not confined to the two farms, many careful experiments being carried out at various centres in the country; thus the main set of tests on the manuring of sugar beet, for example, involves some twenty commercial farms annually.

In a note of this length, it would be impossible to do justice to the work of so many departments; a reviewer can but mention one or two out of many significant lines of work. The experiments on deep ploughing and on cultivations have interested scientific men and farmers for some years, and the resumption of this work is welcomed. Results available before the War indicated that much time and money are lost on the farms of Britain in excessive cultivations; but farmers and Rothamsted workers alike felt that such unexpected results needed more corroboration. It has generally been considered that, in so far as yield of crop is concerned, the more and the deeper the cultivation the better; we used to point out the large, if expensive, crops raised in some gardens, where trenching is carried out, etc., and where no expense is spared on the preparation of the seed bed. The work at Rothamsted, however, which included experiments at many centres in 1944 and 1945, did not indicate any advantage from deep ploughing or from sub-soiling for potatoes or beet, and very little for wheat. Observations of root development and of the physical properties of the soil showed that none of the properties was influenced by deep cultivation.

The theoretical and experimental work on the movement of water in soils, and on evaporation, is also of great interest. Most of us have had the experience of observing small patches of a crop that have made far better growth than that of the surrounding plants, due to some physical character of those portions of the seed bed; for example, consolidation as the result of pressure from a tractor wheel, or greater pulverization on a headland where some implement may have been turned round, and where upward movement of water in the soil was presumably facilitated. On other occasions, under different weather conditions, these excessively consolidated or pulverized areas have carried the poorest plants. It is not easy for even the most experienced farmer to achieve the optimum seed-bed condition every season, and there will always be an element of chance about this until more fundamental knowledge is available about the physical properties of the soil, particularly in regard to water.

The Department of Chemistry commenced work in 1945 on forest nurseries, and interesting results are already available. It is interesting to note, for example, how the growth of Sitka spruce was improved by acidifying a slightly calcareous soil on which this species had consistently failed for a number of years. Work already carried out is sufficient to indicate that fruitful lines of research lie ahead in this field.

Work carried out in the Department of Soil Microbiology on the micro-organisms capable of the selective destruction of soil bacteria may be noted as of particular interest. The maintenance of satisfactory biochemical activity in a field soil depends on several factors, not the least important of which is the existence of micro-organisms that limit the numbers of useful organisms, either by competing with them for nutrients, or by producing toxic secretions, or by directly eating them. A number of strains of bacteria were subjected to attacks by five predatory organisms, and by three species that are destructive to bacteria by virtue of their secretions. It was found that any one species of organism could attack about half the bacterial species tested; the organisms, however, differed markedly as to which particular bacterial strain they attacked. It seems likely that very few species of bacteria exist in the soil that are immune to attack by some of the micro-organisms.

Current advances in the use of insecticides lend great interest to the Rothamsted investigations in that field. Experiments are in progress on various aspects of the use of D.D.T. and of benzene hexachloride, including the effect of these on bees.

Tables giving the detailed results of the experimental work have been omitted, since it is intended to issue these separately. The report includes a list of the scientific papers from each department, with a short note on the contents of each, and also a list of the publications of the Rothamsted Experimental Station.

PACIFIC SCIENCE BOARD

FIRST ANNUAL REPORT

THE first annual report of the Pacific Science Board (National Research Council, Washington 25), set up as a result of the Pacific Science Conference, 1946, covers the year 1947, and outlines the steps being taken under the project for the co-ordinated investigation of Micronesian anthropology to fill gaps in our scientific knowledge of the Marshall, Caroline and Mariana Islands, and to provide the basic information required in setting up civilian government in these trust territories of the United States. A permanent Insect Control Committee has been appointed for Micronesia, and five entomologists have been sent to survey the distribution and destruction of coco-nut palms caused by the rhinoceros beetle (*Oryctes rhinoceros*), to study the coco-nut beetle (*Brontispa mariana*) and the giant African snail (*Achatina fulica*) and to search for parasites or natural enemies for the control of these pests. An entomological survey of the Palau Islands is also in progress.

Approval was given for eight other field projects, and in general the Board's policy is to give stronger endorsement and higher priority to proposals for intensive and long-range research than to those for extensive but superficial surveys or short-term projects. In accordance with the desire to strengthen Honolulu as a centre for research in the Pacific, the Board generally recommends that reference collections from the area should be deposited with appropriate institutions in Honolulu.

The Pacific oceanic biology project is now actively engaged in studying, analysing and evaluating the data already available, with headquarters at the Woods Hole Oceanographic Institution; and plans are now being developed for establishing a new Hawaii Marine Laboratory on an island in Kaneohe Bay, Oahu. The Board also hopes to co-operate with the research council to be set up by the South Pacific Commission in developing plans for research in that area, and conservation planning in the Pacific should be greatly assisted by three forthcoming international conferences: the meeting of the Standing Committee for the Protection of Nature in and around the Pacific, at the Seventh Pacific Science Congress to be held in New Zealand in February 1949; the Economic and Social Council of the United Nations Scientific Conference on the Conservation and Utilization of Resources, to be held in the United States in May 1949; and the United Nations Educational, Scientific and Cultural Organisation's Conference on the Protection of Nature also to be held in the United States in May 1949.

Future activities contemplated include the encouragement of oceanographic and fisheries research in various parts of the Pacific, the initiation of a conservation programme for Micronesia, and the initiation of field studies in the Pacific area to further research bearing on problems in cancer and heart disease.

CARNEGIE UNITED KINGDOM TRUST

THE thirty-fourth annual report of the Carnegie United Kingdom Trust for the year 1947 emphasizes the increasing rate of expenditure, which rose from £120,000 in 1946 to £160,000 in 1947, thus exceeding the annual expendable income of about £133,000. The quinquennial policy for 1946–50 was framed on the assumption, however, that during the period a substantial part of the accumulated savings of the war years would be applied as annual revenue, and the Trustees are more concerned at a second feature of the period—the increasing proportion of expenditure allocated to the provision of services rather than buildings or capital assets.

The largest bulk allocations, totalling £150,000 each, for the Bureau of Current Affairs and for the development of amateur music and art, are wholly concerned with services, and this is also true of the £25,000 allocated to enable local organisers to be appointed by County Federations of Young Farmers' Clubs. Although the 'village hall' allocation of £100,000 is designed to help capital expenditure, payments have amounted to less than £7,500 in two years. Past experience of the Trustees indicates that grants for capital purposes have been more certain in their operation than grants for the early maintenance of services, and accordingly they regret the present restricted opportunities in the capital field. In view of the unsatisfactory position of the village halls scheme, it has been decided that when the Trust allocation of £100,000 has been exhausted by promises, subsequent schemes shall be eligible for consideration for Exchequer grants under the Physical Training and Recreation Act. For the village planning competition, forty-seven entries were received and the winning design is regarded by the adjudicators as quite outstanding. The Trust has also agreed to find up to £400 a year for a two-year programme of pioneer work for young women from the Channel Islands, partly by visits of expert organisers from England and partly by courses of instruction in England.

The report refers to the passing of the Irish Central Library for Students under an independent governing body, the Library Council established by the Public Libraries Act of 1947 (Eire). Grants to three county libraries in Eire have also been agreed in principle, and the committee set up to consider the future of the Scottish Central Library reported unanimously in September 1947 that the Library should not be merged with the National Central Library, although continuing to work in the closest co-operation and consultation with that Library. Some form of constitutional link between the two Libraries was recommended; but it was considered that the time was now ripe for establishing the Scottish Central Library on an independent basis, with its own trustees and governing body and an initial income of £5,000, in new premises in Edinburgh. The grant to the National Central Library has been progressively decreased to £3,000, £2,000 and £1,000 for the three ensuing years and will become extinct on December 31, 1950.

Sufficient progress has been made with the Shropshire Community House at Attingham Hall, near Shrewsbury, to justify the appointment of a warden, and the Highlands and Islands Film Guild has made a very satisfactory start and is now working on a programme of six mobile film units.

STANDARD FREQUENCY TRANSMISSIONS IN GREAT BRITAIN

THE question of radiating standard frequency transmissions from Great Britain has recently been under consideration. Such transmissions are of great value in connexion with the calibration of industrial and scientific frequency sub-standards, in connexion with work on radio wave propagation and also for survey purposes. At present, standard frequency transmissions of guaranteed accuracy are emitted by the U.S. National Bureau of Standards[1] continuously on the eight frequencies 2·5, 5, 10, 15, 20, 25, 30 and 35 Mc./s. from station WWV. Unfortunately, on account of radio propagation conditions, it is often difficult to make good use of the American transmissions in Europe and farther east. At the recent meeting of the International Telecommunications Union at Atlantic City, it was agreed that the first six of the above frequencies (namely, 2·5, 5, 10, 15, 20 and 25 Mc./s.) should be allocated on a world-wide basis for all future standard frequency transmissions. Hence, if undesirable interference between such transmissions is to be avoided, all new services of standard frequency transmissions will require very careful co-ordination with existing services.

In Great Britain, an experimental low-power transmission from station GMT, on a frequency of 2 Mc./s., has been set up by the Royal Observatory at Abinger, Surrey, to facilitate comparisons between quartz clocks used in the operation of the Greenwich time service. Details of this service have been published recently[2]. Since no other British standard frequency service is at present available, these transmissions have been fairly widely used, and a substantial increase in power is under consideration.

In existing circumstances the provision in Britain of a comprehensive service on a number of the available frequencies will take some considerable time; but arrangements are now under consideration whereby a limited standard frequency service on three frequencies will be operated by the General Post Office. It is hoped that experiments connected with the new service will demonstrate the feasibility and value of covering the United Kingdom and Europe in this way, and also the degree of interference from and with the WWV transmissions.

Details of this experimental service will be announced later; but meanwhile it may be mentioned that the frequencies of the following transmitters of the General Post Office and of the B.B.C. are maintained at their nominal values to a tolerance better than ± 1 part in 10^6.

Station's call sign	Nature of service	Location	Nominal frequency kc./s.
GBR	Telegraph	Rugby	16
—	Broadcast	Droitwich	200
GRO	Broadcast	Skelton	6,180
GSB	Broadcast	Daventry	9,510
GSV	Broadcast	Daventry	17,810

The B.B.C. medium-wave transmitters, with the exception of that on 583 kc./s. (514 m.), are also maintained on their nominal frequencies to a tolerance of approximately ± 1 part in 10^6.

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[1] National Bureau of Standards (U.S.A.). Letter Circular LC886, January 30, 1948.

[2] *Wireless World*, 53, 439 (Nov., 1947).

ELECTRIC CONDUCTIVITY OF ROCKS AT HIGH TEMPERATURES

H. P. COSTER has described the results of measurements of the electric conductivities of various rocks (*Mon. Not. Roy. Astro. Soc.*, Geophys. Supp., 5, No. 6, January 1948). The conductivity was determined on specimens of rock cut in the shape of a cylinder, by measuring the resistance between the electrodes in a D.C. bridge circuit; the current in the bridge was reversed after balancing, with the object of detecting potentials due to polarization of the rock by electrolysis. Although a small effect was usually found, its influence on the resistance was never more than a few per cent. The conductivities determined for different rocks showed that they could be classified as semi-conductors, and in many semi-conductors the relation between the conductivity and the absolute temperature T is given by

$$\sigma = A_1 \exp(-\varepsilon_1/kT) + A_2 \exp(-\varepsilon_2/kT) + \ldots,$$

where k is Boltzmann's constant, $\varepsilon_1, \varepsilon_2$, etc., are the activation energies of the various processes to which the conductivity is due, and A_1, A_2, etc., are constants.

The results of the experiments are shown graphically, $\log_{10} \sigma$ being plotted against $10^3/T$, for eight different rocks—all Scottish—which Prof. C. E. Tilley placed at the disposal of the author. The curves show that the conductivity of most of the rocks is due to at least two mechanisms: one with an activation energy of about 0·7 volt and the other with an activation energy of the order of 2 volts, the latter appearing at higher temperatures; experiments on the nature of the conductivity suggest that in this case it is caused by moving ions.

The theoretical implications of the results with regard to the conductivity in the interior of the earth are discussed, and the following suggestions are made. At a depth of a few kilometres where the rocks are probably dry, the conductivity is lower than it is nearer the surface; but as greater depths are reached, where the temperature is higher, the conductivity should start to increase. Assuming that pressure has no effect on the conductivity, a value of 0·01 $\text{ohm}^{-1}\ \text{cm.}^{-1}$ should be reached at a temperature of 1,200–1,400° C., possibly at a depth of 160 km. The effect of pressure is, however, a serious source of uncertainty in the investigation; but using the temperatures and pressures given by Bullard and Bullen, respectively, Coster has compiled a table which shows the variation of temperature, pressure and conductivity with depth, though the relation cannot be regarded as anything more than an approximation. At depths greater than 200 km. the increase in conductivity is rather small, because the effect of increase in temperature is almost compensated by that of increase in pressure. The figures, though giving only a rough idea of the variation of conductivity with depth, nevertheless can account for the increase of conductivity with depth found by Chapman and Price.

MEXICAN VILLAGE LIFE

THE monograph under notice*, the sixth of a series dealing with the sociology of Latin America, returns to the Mexican Highlands and to the Tarascan pueblo of Tzintzunzan. This village, which at the time of the Spanish conquest was the capital of an empire second only to the Aztec in size, has now become a sleepy Mestizo community of 1,500 souls which is "probably typical of a vast number of small rural Mexican pueblos". "Empire's Children" is a very readable account of this engaging and happy-go-lucky community of potters and farmers where "the great majority of the villagers get down to work only with a tremendous exertion of will power and stop on the slightest pretext", and where "Russia, Communism, the United States and Protestantism are conveniently lumped together as enemies of the inalienable rights of man".

The author's purpose is to convey a general and comprehensive impression of the social and economic life of these people, and he has been more than usually successful in achieving this. The reader is neither overwhelmed with masses of unnecessary detail nor mystified by technical anthropological jargon, and yet practically every aspect of village life is covered—its history and prehistory, its domestic and its material culture, its trade and commerce and its social, political and religious institutions. His summing up and conclusions are not so impressive, probably because of his short acquaintance with the country (two years) and possibly because although he admits the essential unity of the Mestizo culture, he remains too preoccupied in distinguishing the Spanish and Tarascan traits which contribute to its 'total configuration'. However, this summary only takes up eight pages at the end of the monograph and is probably inserted for the benefit of the Mexican Government rather than for the general reader.

It is to be hoped that this preliminary survey will be succeeded by detailed studies of the more striking aspects of rural Mexican society, in particular, of the part played by the Church, a role so vital that Foster considers it the "socio-spiritual focal point of the culture".

G. I. JONES

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* Empire's Children. The People of Tzintzunzan. By George M. Foster assisted by Gabriel Ospina. Pp. v+297+16 plates. (Pub. No. 6, Institute of Social Anthropology, Smithsonian Institution, Washington, D.C.)

See also *Nature*, 161, 697 (1948) for notice of Pub. 2–5 of this series.

SOIL IMPROVEMENT FOR FORESTRY

THE Reports of the Forest Research Institute of Sweden, Vol. 36 (Centraltryckeriet, Esselte AB, Stockholm, 1948) contains papers of considerable interest. Omitting those dealing with volume and other measurements made in different parts of the country, sample plots and yield tables, and papers on forest pests, an article of importance to other countries is that of Carl Olof Tamm entitled "Soil-improving Measures Tried on a Poor Site". The work is described as a final report on work started in 1922 by the Swedish Institute of Forest Research in co-operation with the Forest Protection Board of the district of Jönköping, following an initiative taken by W. Lothigius, who was at that time the Board's executive forest officer. The aim of the work has been to try some possibilities of raising the poor forest yield frequently found on sandy soils within the district and elsewhere in the province of Smaland. Earlier reports have been published by O. Tamm, who planned the experiments and was responsible for collecting data on the plots as long as he remained with the Institute (up to 1938).

The plots are at lat. 57° 34′ N., long. 22° 12′ E. They occupy an area known as the Mölna Field on a sand flat that was formerly mostly covered by old forest. In the experimental field, the forest was felled during 1918–19.

After describing the area and its previous vegetative covering, the methods of re-afforestation are treated by means of a number of experimental plots. Nine strips were laid out, numbered III–XI, each 50 mm. wide. Furthermore, the main experiment is divided in ten rows, crossing the strips at right angles. Row No. 7 is 37·5 m. wide, Row No. 8 is 62·5 m.; all other rows are 25 m. wide.

Strips Nos. III and V were sown in 1923 with pine mixed with spruce. In strip No. III the mor cover around each seedspot was loosened and mixed with the sand: no positive effect of this treatment was ever observed. At the same time, strip No. IV was planted with birch (about 1,000 per hectare, side-hole planting) and then sown with pine mixed with spruce. Strip No. VI was planted with *Alnus incana* instead of birch, and sown with pine.

Strip No. VII and the following strips were planted in 1922, the former with pine 1/0 and spruce 2/0 (ratio 2 : 1), No. VIII with birch as No. IV and pine and spruce, No. IX with pine and spruce, No. X with *Alnus incana* as No. VI and pine, and No. XI with pine only. The conifer seedlings were planted by the slit method.

The number of seedspots per hectare was intended to be 6,000 all over the field, but this figure is rather approximate. All pine and spruce seed used came from the same province; but the birch and *Alnus incana* seedlings originated from Bastad (Skåne).

In Strip No. VII each planting hole was manured with peat from a birch carr; seven or eight litres of peat were mixed with the earth in each hole before planting. The other treatments were done in different rows. The rows Nos. 1, 3, 5 and 7 were controls (no treatment). Within rows Nos. 2 and 6 the soil was ripped by a kind of harrow. Within row No. 4 about 400 gm. lime (calcium carbonate was used from the sulphate mill at Gotafors) was mixed in each hole. Within rows Nos. 8 and 10 tree-debris from the clear felling were removed and taken to row No. 9.

Most of the pines, planted or sown, grew well in the first few following years. The planted spruces grew well, too; but the spruce seed used had a poor capacity of germination. The birches and alder seedlings generally did not stand the hard conditions at Molna Field, especially the frosty climate. Within small areas seedlings of all kinds suffered, either from fungus injuries or from starvation. Attempts were made to fill blanks by repair plantings in 1926 and 1930.

Two diagrams give results from observations in 1932. The brush-manured row (No. 9) had a small number of seedlings but a high percentage of good pine. Many seedlings were spoiled by capercailzies that found shelter in the brush cover. The peat strip (No. VII) showed a slight excess over the others, both in number of seedlings and in percentage of good pine. None of these deviations is significant.

The paper should be consulted for full details. In summing up, the author writes: "The Mölna experiment has been helpful in drawing attention to some factors determining forest yield on poor sandy soils. Yet, in order to have a more definite idea of the parts played by humus conditions, on one hand, and by geology on the other, fresh data must be obtained on plots where the conditions at the start of the experiments are carefully determined. The problems at issue have proved much more complicated than was realized in 1920."

SOME FUNGI OF INDIA

SIX new species of fungi occurring in Mysore have been described by M. J. Thirmulachar (*Trans. Brit. Mycol. Soc.*, 31, 1; July 1947). *Sphaceloma santali* attacks the leaves of the sandal tree; *S. osyridis* parasitizes leaves of *Osyris Wightiana*; *S. oleanderi* produces an anthracnose on oleander, and *S. curcumæ* causes leaf-spot of wild turmerics. *Cladochytrium aneuræ* is an interesting species weakly parasitic within the thallus of a liverwort (*Aneura* sp.), and *Leptosphæria porellæ* causes wilting of the bryophyte *Porella*. Mycological descriptions of the new species are given. Two further new species of *Physalospora* attacking *Pterolobium indicum* and *Heterostemma tanjorense*, two species of *Septoria* parasitizing *Erythrina* sp. and *Thespesia populnea*, with *Cereospora adinæ* on its name host, are fully described by T. S. and K. Ramakrishnan (*Proc. Ind. Acad. Sci.*, B, 26, No. 1, 7; July 1947).

Several papers have also been published on *Phytophthora palmivora*, which causes a fruit rot of tomatoes and a seedling blight of *Hibiscus esculentus*. T. S. Ramakrishnan and C. K. Soumini have studied the fungus on tomatoes (*Proc. Ind. Acad. Sci.*, B, 25, No. 2, 39; Feb. 1947). They isolated the fungus, proved its pathogenicity, found it could enter unwounded fruits, and, as infection appears most readily on fruits in contact with the soil, suggested proper support of tomato plants as a simple means of prevention. M. S. Balakrishnan (*Proc. Ind. Acad. Sci.*, B, 26, No. 4, 142; Oct. 1947) established the pathogenicity of *P. palmivora* on *Hibiscus* seedlings. A minus strain was isolated, and did not form oospores until paired with a plus strain of the same species. Further studies on this heterothallism have been made by K. M. Thomas, T. S. Ramakrishnan, C. K. Soumini and M. S. Balakrishnan (*Proc. Ind. Acad. Sci.*, B, 26, 147; Oct. 1947).

R. P. Asthana has investigated several characters of *Sclerotium cepivorum* and *S. tuliparum* (*Proc. Ind.*

Acad. Sci., B, 26, No. 3, 93; Sept. 1947). *S. cepivorum* grows best on an acid medium, whereas *S. tuliparum* favours neutral or slightly alkaline conditions. Both species have an optimum temperature of 20° C. Neither species is able to attack the host of the other; but *S. tuliparum* can infect several bulbous plants in addition to the tulip. Both species secrete pectinase, though there is evidence that each host type is more sensitive to the enzyme of its specific parasite than to that from the other.

A threefold chain of parasitism is described by S. Y. Padmanabhan (*Proc. Ind. Acad. Sci.*, B, 26, No. 3, 77; Sept. 1947), who found a species of *Fusarium* attacking pupæ of *Epipyrops*, which in the larval stage is a parasite of *Pyrilla*, a pest of sugar-cane. The fungus is variable in culture, but is regarded as *F. moniliforme* var. *subglutinans*. Six new hosts of the ergot fungus *Claviceps* are given by T. S. Ramakrishnan (*Proc. Ind. Acad. Sci.*, B, 26, No. 4, 136; Oct. 1947), who also describes the fungus upon each. Miss H. Sunanda Kamath investigated the life-history of *Puccinia ruelliœ* on *Ruellia prostrata*, a common perennial weed in south India. It was found to be a macro-cyclic, autœcious rust, and the sequence of development of all the spore forms was followed by inoculation experiments.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lecturer in Botany—The Registrar, The University, Nottingham (August 21).

David Brown Scholarship in Agricultural Engineering—The Registrar, King's College, Newcastle-upon-Tyne (August 21).

Paint and Vegetable Oil Chemist (graduate) to take charge of research and to teach a small post-graduate class, and a Graduate Technologist to teach vegetable oil extracting and paint manufacturing processes, at the Instituto de Oleos, Rio de Janeiro—The Director, Personnel Department, British Council, 3 Hanover Street, London, W.1 (August 21).

Physiologist (male) with an Honours degree in Science, and a Bacteriologist with Honours degree, or an Honours Graduate in Science with experience in Bacteriology—The Secretary, Hannah Dairy Research Institute, Kirkhill, Ayr (August 21).

Lecturer (man or woman) in Agricultural Sciences at the Cheshire School of Agriculture, Reaseheath—The Director of Education, County Education Offices, City Road, Chester (August 21).

Ford Motor Company Scholarships in Agricultural Engineering—The Registrar, King's College, Newcastle-upon-Tyne (August 21).

Lecturer (Grade III) in the Department of Geography (with special qualifications in Meteorology and/or Geomorphology)—The Clerk, Birkbeck College, Breams Buildings, London, E.C.4 (August 21).

Demonstrator of Physics—The Dean, Medical School, Guy's Hospital, London, S.E.1 (August 23).

Scientific Officer (Zoologist, for work especially on plankton) at the Millport Laboratory—The Secretary, Scottish Marine Biological Association, 185 St. Vincent Street, Glasgow, C.2 (August 24).

Lecturer or Assistant Lecturer in Structural Engineering—The Registrar, College of Technology, Manchester 1 (August 30).

Assistant in Zoology for Research in Entomology, with minor teaching duties—The Secretary of University Court, The University, Glasgow (August 31).

Agriculturist in the Southern Rhodesia Government Service—The Office of the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (August 31).

Lecturer in Chemistry with special qualification in physical chemistry—The Secretary, The University, Old College, South Bridge, Edinburgh (September 1).

Lecturers in Mathematics, and Lecturers in Science (physics, mechanical or electrical engineering, or chemistry), at the Royal Military Academy, Sandhurst—The Secretary, Civil Service Commission, Burlington Gardens, London, W.1, quoting No. 2254 (September 4).

Lecturer in Social Science and Supervisor of Studies for the Diploma Course in Social Science—The Registrar, University College, Singleton Park, Swansea (September 11).

Cargill Chair of Natural Philosophy, tenable in the subject of Theoretical Physics—The Secretary of University Court, The University, Glasgow (September 11).

Assistant Inspectors of Mines and Quarries under the Ministry of Fuel and Power—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2246 (September 11).

Director of Museums to take charge of the Museum Section of the Art Galleries and Museums Department—The Town Clerk, City Chambers, Glasgow, C.2 (September 15).

Chair of Applied Mathematics—The Registrar, University College, Southampton (September 20).

Lecturer in Geology, within the Department of Agricultural Chemistry, and an Assistant Lecturer in Plant Diseases in the Department of Agricultural Botany—The Secretary and Registrar, University College of North Wales, Bangor (September 25).

Smithson Research Fellowship—The Assistant Secretary, Royal Society, Burlington House, Piccadilly, London, W.1 (October 30).

Tucker-Price Scientific Research Fellowship in mathematics, science or an allied subject—The Secretary, Girton College, Cambridge, (January 15).

Chemist in the Department of Chemistry, Tanganyika—The Director of Recruitment (Colonial Service), Colonial Office, 2 Sanctuary Buildings, Great Smith Street, London, S.W.1.

University Graduates and Qualified Teachers, with qualifications in mathematics, science, engineering, or in geography with mathematics up to intermediate degree standard, for Short Service Commissions in the Education Service, Royal Navy—The Director (P), Education Department, Admiralty, London, S.W.1.

Lecturer in Mathematics to B.Sc. standard, a Lecturer in Chemistry to B.Sc. standard, and a Lecturer in Physics to B.Sc. (Special) standard—The Clerk, Northern Polytechnic, Holloway, London, N.7.

Technician for the Department of Zoology—The Clerk, Birkbeck College, Breams Buildings, London, E.C.4.

Laboratory Technician (bacteriological technique essential) in the Pathology Department—The Secretary, Welsh National School of Medicine, 10 The Parade, Cardiff.

Soil Survey Officer—The Secretary, Rothamsted Experimental Station, Harpenden, Herts.

Research Metallurgist, and a Senior Assistant in the Information Department—The Secretary, British Non-Ferrous Metals Research Association, 81–91 Euston Street, London, N.W.1.

Assistant Technician for university laboratory involving botanical and chemical work—Dr. J. W. Fairbairn, School of Pharmacy, 17 Bloomsbury Square, London, W.C.1.

Scientific Assistant with a knowledge of electronics for work in X-Ray crystallography—Dr. W. A. Wooster, Cavendish Laboratory, Cambridge.

Technical Officer (with a degree or diploma in, and a sound practical knowledge of, horticulture)—The Curator, John Innes Horticultural Institution, 31 Mostyn Road, London, S.W.20.

Veterinary Research Officers (2) in the Sudan Veterinary Service, for supervising the preparation of various biological products and carrying out general research—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Veterinary Research Officer'.

Scientific Officer and Experimental Officer Grades in Ministry of Supply Research Establishments in the following fields of work: Chemistry—Inorganic, Organic, Physical, Analytical, and Chemical Engineering (Ref.F.355/48A); Biochemistry, Physiology, Pharmacology (Ref.G.184/48A); Aerodynamics—subsonic and supersonic in wind tunnels and in flight (Ref.A.160/48A); Aircraft Structural Theory (Ref.C.301/48A); Gas Turbines, jet and rocket propulsion at supersonic speeds (Ref.C.299/48A); Physics, including optics, gas kinetics and thermodynamics (Ref.A.159/48A); Radar (Ref.A.161/48A); Aircraft Instrumentation and electrical and radio accessories, etc. (Ref.C.300/48A); Metallurgy, X-Ray diffraction, electron microscopy, inter-crystalline corrosion, high temperature materials (Ref.F.356/48A); Mathematical Applications, including ballistics, statistics (Ref.A.158/48A)—The Technical and Scientific Register (K), York House, Kingsway, London, W.C.2.

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

The Independent Research Institute. (Technical Bulletin No. 1.) Pp. 8. (Garston Manor, Watford: Garston Manor Research Institute, 1948.) [36

British Thunderstorms. Vol. 2: 1934–37, Part 3: 1936–37. Edited by S. Morris Bower. Pp. iv+97–144. (Huddersfield: Thunderstorm Census Organisation, 1947.) 5*s*. [36

Medical Research Council. Memorandum No. 18: Thyroid Enlargement and other Changes related to the Mineral Content of Drinking Water (with a Note on Goitre Prophylaxis). By Dr. Margaret M. Murray, Dr. J. A. Ryle, Dr. Beatrice W. Simpson and Dr. Dagmar C. Wilson. Pp. 40. (London: H.M. Stationery Office, 1948.) 9*d*. net. [36

Department of Scientific and Industrial Research. Report of the Geological Survey Board for the Year 1946. Pp. ii+10. (London: H.M. Stationery Office, 1948.) 4*d*. net. [36

Other Countries

Physiologia Plantarum. Scandinavian Journal covering all Branches of Plant Physiology. (Official Publication of the Scandinavian Society for Plant Physiology.) Quarterly. Vol. 1, Fasc. 1. Pp. 112. (Copenhagen: Einar Munksgaard, 1948.) 40 kroner a Year. [36

Feeding Problems in Man as related to Environment: an Analysis of United States and Canadian Army Ration Trials and Surveys, 1941–1946. By Dr. Robert E. Johnson and Robert M. Kark. Pp. viii+94. (Chicago: U.S. Army Medical Nutrition Laboratory, 1947.) [36

Catalogues

The New Universal Flamemaster Hand Torch. (Smethwick: Chance Brothers, Ltd.; London: W. Edwards and Co., Ltd., 1948.)

Catalogue of New Books on Chemistry and Chemical Industry. Pp. 58. (London: H. K. Lewis and Co., Ltd., 1948.)

Sondes Place Research Institute. Pp. 16. (Dorking and London: Mactaggart and Evans, Ltd., 1948.)

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THE ROCKEFELLER FOUNDATION

THE reviews of the work of the Rockefeller Foundation which we are accustomed to receive from its President are far more than mere summaries of the activities of the Foundation during the year under review. They represent an intellectual stock-taking—an assessment of the position of the creative forces of civilization, its moral and spiritual, as well as scientific, resources, and an attempt to appraise the directions in which special efforts are required. Dr. Fosdick's review of 1947 is no exception, and with insight and courage delineates the challenge which Western society faces to-day and the points at which special efforts are necessary to avert pressing danger.

Dr. Fosdick starts his review with a glance at the appropriations of the Foundation during 1947. Amounting to 23,413,615 dollars, or nearly four million dollars more than those in 1946, they represent the largest annual appropriation in the history of the Foundation. They include a single grant of ten million dollars to the China Medical Board for the support of the Peiping Union Medical College, another 2,225,000 dollars for public health, and 1,500,000 for medical sciences, 1,700,000 for natural science, 3,000,000 for social sciences and 1,500,000 dollars each for the humanities and for the General Education Board. Of this total 39 per cent was for work in the United States and 61 per cent for work in other countries.

The central issue to which Dr. Fosdick directs attention in this report is that of the misuse of knowledge, and while he recognizes that in the present situation an element of physical force is essential he insists that that alone will be of no avail unless we meet the challenge on an intellectual and ethical plane. Here the emphasis on the task of raising the material standards of living can be an obstacle. A solid material foundation may be an essential basis for a high civilization; but Dr. Fosdick points out that it is a basis and not a superstructure. So, too, our reverence for the physical sciences and acceptance of the doctrine that civilization can be bred to greatness and splendour by science hinders our responding to the challenge at a higher level. The gap between the physical sciences and the humanities and social studies, in terms of endowment, research facilities and teaching staffs, needs to be closed, whereas in fact it is growing wider.

Dr. Fosdick recognizes the debt which mankind owes to science in giving us the methods and patterns of research in human relationships; but he insists that to the problem of discovering a new set of human purposes, to the art of human relations, to the winning of wisdom, physics, chemistry and engineering contribute little. They are ethically neutral, and the issues of our time and of human destiny will be determined not at the physical but at the ethical and social levels. If this age is to achieve greatness it will not be through its physical triumphs, but through the discovery of an enlightened humanism and of new spiritual and moral values that lead men forward.

The immediate task, in Dr. Fosdick's view, is to discover the common interests, the areas in which collaboration is possible, where curiosity and sympathy, aspiration and mutual advantage overlap. The search for these rallying points, the development of new techniques and areas of co-operation where ideas and experience can be pooled and combined, lays the foundation of the ultimate structure of a unity never yet achieved in the world. In this connexion it should be noted that while representatives of the Rockefeller Foundation visited practically every country in the world in 1947, visas to enter Bulgaria and the Soviet Union could not be obtained and no contact could be established with their scholars and scientists. And in all the countries which representatives of the Foundation visited the passionate desire for peace, security and a better life formed the universal pattern of thinking and planning, whatever the differences of opinion as to the means by which these ends are to be achieved.

We have already noted in these columns Dr. Fosdick's comments on the unhappy effects of isolationism on science and the major responsibility which here rests on the Soviet Union. It is because medicine stands so clearly above political ideology that Dr. Fosdick justifies the large appropriation for the development of modern medicine in China at the present time, as he does the increasing support given in the field of public health. There also the widening horizons, the fading of the borderlines between curative and preventive medicine, are giving public health the stature of a social science in the service of society. Dr. Fosdick clearly looks upon the World Health Organisation of the United Nations as a real unifying force in the world and one vehicle through which our new knowledge and widening conceptions of public welfare may make health, if not infectious, at least within the reach of all men.

Another unifying factor, at least in the world of science, is what Dr. Fosdick describes as the cross-breeding of biology with physics as well as chemistry. Biophysics, in particular, with its demands for such expensive equipment as ultracentrifuges, X-ray equipment, spectrophotometers and cyclotrons, demands co-operation across national frontiers, and the Foundation made a number of large grants in this field in 1947, including 250,000 dollars to the Massachusetts Institute of Technology, 50,000 dollars to the California Institute of Technology, 85,000 dollars to Prof. W. T. Astbury at Leeds, and 21,000 dollars to Prof. J. T. Randall, director of the Biophysics Unit of King's College, London.

Of the grants in the field of social sciences and in the humanities, Dr. Fosdick observes that they are intended to assist a more adequate analysis and understanding of the issues in international relations, to widen the horizons of the political and economic life of men, to extend the frontiers of the mind in time as well as in space. The programme of research assisted from this point of view also has claims upon the interest of the physical as well as of the social scientist. One particular problem is of exceptional interest at the present moment and is a challenge to this country which is unmistakable.

During 1947 Dr. R. J. Havighurst, of the University of Chicago, made an extensive study for the Foundation of the situation in Germany as regards the universities, primary and secondary schools, libraries, youth problems and policies, teacher training, contacts with the outside world and so on. Dr. Fosdick summarizes very briefly the observations and recommendations of this report, stressing the poverty of Germany and the utter isolation which affects many men of goodwill in Germany, and asserting that nevertheless the foundations for a peaceful and productive democratic society are present in Germany to-day. Moreover, the two prerequisites to the development of such a democratic society—the restoration of communications between the Germans and the people of other countries, and the development of younger leaders who know the world outside of Germany—are steps no less needed in Austria and Italy, as well as in all the countries where people have been cut off from free and natural intercourse with the people of other countries.

In addition to its regular European programme, the Rockefeller Foundation in 1947 set aside 500,000 dollars for work in this field of European reconstruction. The examples of these appropriations cited b Dr. Fosdick indicate the challenge that the Foundation's work represents to Britain, which no less than the United States bears responsibility for administration in Germany. The sum of 120,000 dollars has been given to the University of Chicago to set up an American faculty in the University of Frankfurt. From six to ten university professors from Chicago, selected primarily from the field of the social sciences and the humanities, will be constantly in residence at Frankfurt for periods of at least six months. A grant of 60,000 dollars over three years to the Germanistic Society of America is for the supply of scholarly periodicals to fifteen German and three Austrian university libraries, and a grant of 25,000 dollars to Columbia University is intended to facilitate the establishment of German radio as a public service free from political control by bringing to Great Britain, the United States and Canada, leading German personnel from German radio stations to acquaint them with the rights and responsibilities of British, American and Canadian radio.

These are precedents which deserve to be marked and studied by the British Government and universities as well as men of science. As Mr. Kenneth Lindsay has urged, it is a time to increase and not to restrict, as has been done, for example, with book imports, cultural relations of all kinds, at least between those countries within the Marshall plan and the United States. To be fully effective, politica and economic organs must be matched with th acceptance of common values which in general terms, must permeate the schools and the universities. Moreover, the universities carry a large measure of responsibility for establishing a community of ideas and ideals.

An important factor to both these ends is th interchange of teachers and students. That interchange has been sadly interrupted during the past year by travel restrictions, direct and indirect, and though the British Council is doing something in this field, as has been pointed out in *The Universities Quarterly*, its postgraduate courses for American and other overseas students at British universities are prohibitive in their cost for most students from European countries. Here it would seem is an opportunity for Government action to relax restrictions at least. Again, it may be asking too much of any one British university at the present moment to establish faculties in German universities on the scale which, through the Rockefeller Foundation, the University of Chicago has done at Frankfurt. But can nothing on these lines be done corporately by the combined universities ? Rather we might ask, can this country afford not to do so ? General Robertson has recently set up a Commission of eleven members, of which the Master of Balliol is the one British member, to examine the state of the universities and technical schools in the British zone in Germany. That Commission will function with essentially the same freedom as a Royal Commission in Britain and may be expected to address itself with wisdom and energy to the task of university reform. Its composition should dispel any fears that reforms will be recommended which break drastically with the past and the German idea of a university as a home of mature learning and research.

But if the German universities are to meet the demands which will be made upon them in the reconstruction period, if the younger teachers are to be enabled to take the part which they could usefully play in the government of academic life, if that isolation to which all observers bear witness is to be removed, interchanges on such lines must make a large contribution. Books and periodicals have their place; but the interchange of staff and of students is as important for the revival of learning and the development of the German universities to meet their new opportunities as it is for the presentation and interpretation of the constructive side of British policy and of the British way of life.

Significantly enough in the recent debate on Overseas Information Services that aspect of the question escaped notice, though it might well have been one compelling reason for the Government to relax some of the restrictions hampering such interchange if not for encouraging them by direct financial support.

Large as is the measure of responsibility resting upon the Government here the main driving force to action must come from the man of science and those nurtured with him in the universities who in those seats of learning have not only entered on the great heritage of Western civilization but have understood how great are the issues in the threat to liberty of thought, of investigation and of utterance in the modern world. In his passage dealing with the problem of Germany Dr. Fosdick crystallizes the essence of that challenge not only to Germany and Western Europe but also to the rest of the world, and he indicates some of the ways in which the man of science might work to overcome the lack of will and the lack of light by which, as John Masefield has warned us, one great land after another may be herded into a Dark Age in a very little time. The misuse and disuse of knowledge will only be averted as men of science answer that call, and, no longer content to enlarge the boundaries of knowledge in the laboratory, insist also on clearing the blocked channels of communication of knowledge and ideas, and seek to foster that cultural fellowship and intercourse in which the greatest and noblest elements in the heritage of the West find full and free expression.

REACTION KINETICS IN SOLUTION

The Kinetics of Reactions in Solution

By Dr. E. A. Moelwyn-Hughes. Second edition. Pp. viii+424. (Oxford : Clarendon Press ; London : Oxford University Press, 1947.) 25*s*. net.

WHEN the first edition of this book appeared in 1933, it was not generally believed that reaction kinetics in solution could be profitably interpreted on a molecular basis, and there was relatively little planned experimental work of high accuracy. The author then attempted to show that a simple kinetic picture would account for a large number of the observed facts, and the success of this attempt provided an important stimulus for later theoretical and experimental work on reaction kinetics in solution. The amount of such work during the last fifteen years is very large, and the task of producing a second edition of the book must have been a formidable one.

In many respects the new edition reflects the great expansion which the subject has undergone : thus it contains **144** tables of numerical data, and references to original papers by more than a thousand authors. It is an admirable feature of the book that the data for many reactions are examined in detail, with a clear analysis of possible experimental errors and complications due to reversible, competing and consecutive reactions. The book thus provides a valuable and critical guide to a large range of experimental work, including related topics such as reactions taking place at a liquid–solid interface, reactions in surface films, and enzyme reactions.

On the theoretical side it is no longer necessary to wage a crusade for the application of molecular kinetics to reactions in solution, and the task is rather that of conducting a comprehensible tour through the many alternative formulations and refinements which have arisen since 1933. Dr. Moelwyn-Hughes has given pride of place to a particular type of development, namely, the elaboration of the simple collision theory by adding electrostatic terms for the mutual interactions of ions and dipoles, the solvent being regarded as a continuous medium. This procedure produces at least the appearance of a quantitative theory, and the present book derives and compares with experiment a large number of electrostatic expressions. Unfortunately, most of these expressions contain one or more adjustable parameters which have to be derived from the kinetic data, and all that can be demonstrated is that these parameters usually have a physically plausible value. In these circumstances many would prefer to adopt a superficially more qualitative treatment, which gives a picture of the part played by the individual molecules of solute and solvent and avoids the use of a macroscopic dielectric constant of doubtful significance.

It is remarkable that the terms 'transition state' and 'critical complex' do not occur in an index with more than 700 entries, and that the quasi-thermodynamic method is scarcely used at all in the book. It is true that the statistical equations of the transition state method are worked out in an appendix, but (as the author himself points out) they are of little service in predicting absolute reaction-rates in solution. The value of thermodynamic analogy does not lie in detailed calculation, but in the insight which it gives into the parallel effects of various factors (temperature, pressure, solvent, etc.) on reaction velocities and on equilibria. This aspect of the matter has not been clearly dealt with, and the chapter on "Equilibria" is concerned chiefly with the reverse process of explaining equilibrium constants in terms of kinetic considerations. At best, this procedure provides a derivation of familiar relations which is cumbrous and of limited validity, and at times it produces some curious results, for example (p. 196), an expression for an electrolytic dissociation constant which involves the viscosity of the solvent. This chapter might with advantage have been curtailed, or even omitted altogether.

It is possible to criticize a number of the author's detailed statements ; for example, that an observed reaction order of two shows the slowest step to be bimolecular (p. 49), and that the slowness of esterification reactions in the gas phase must be due to a low collision factor (p. 242). However, in spite of this, and the more general criticisms indicated above, the author has given a useful survey of much recent material. If he has at times failed to give a clear picture of its significance, this is due, at least in part, to the great bulk of experimental work, and to the many and diverse interpretations which have been advanced.

R. P. BELL

PROPERTIES OF SLOW ELECTRONS IN GASES

Electrons in Gases

By Sir John Townsend. Pp. viii + 166. (London : Hutchinson's Scientific and Technical Publications, n.d.) 25*s.*

DISCHARGE phenomena, which may be as varied as lightning, the operation of counters, or the growth of photo-electric currents, all depend upon the mechanics of electrons in gases. Any picture of those processes which involve electron and atom collisions must be built upon experimental determinations of such factors as the atomic cross-section and the fractional loss of energy in collision. Further, the related entities of electron-drift speed and energy of agitation, or temperature, and probably the process of attachment also, depend upon those factors through the electron-energy distribution function. This function depends upon the electric intensity, the gas concentration, and on the variation of atomic cross-section with velocity, and thus varies from gas to gas in a manner which, for any given case, is at present best found experimentally.

For this reason the subject-matter of "Electrons in Gases" is of fundamental significance. The experimental work described is mainly that carried out by Sir John Townsend and his collaborators in Oxford since the publication of his treatise "Electricity in Gases" ; and the present book, which is a research monograph, makes an interesting sequel. The description of the determinations of the mean electron energies and the atomic cross-sections for slow electrons by the diffusion method is very useful, as this technique has proved to be powerful and of wide application. In the higher energy range the results are fundamental in discharge physics ; but recent work on the interaction of radio waves in the ionosphere shows that the technique is also capable of giving important data in this field, where the electron energies are comparatively low and do not greatly exceed thermal values.

The book is confined mainly to giving the theory of the experimental methods and the results obtained : space does not permit full discussion of theoretical derivations of energy-distribution functions when considerable excitation and ionization occur. Except for a treatment of the electric spark at low pressures, other discharge phenomena lie outside the scope of the book : such applications have been treated in Townsend's earlier treatise and in later books on the subject by others. On the other hand, valuable data on the ionization coefficients in pure monatomic gases are given, and the book, which unfortunately lacks an index, can be strongly recommended to those engaged in research in this field.

F. LLEWELLYN JONES

PARTHENOGENETIC PATERNITY IN CENTRAL AUSTRALIA

Aranda Traditions

By T. G. H. Strehlow. Pp. xxii + 181 + 10 plates. (Melbourne : Melbourne University Press, 1947.) 17*s.* 6*d.* net.

IN the early days of the discovery of Australia by the whites, the aboriginals, or black fellows, were stigmatized as degenerate, treacherous and quite untamable. More sympathetic study of these people has, however, rather changed this uncompromising attitude, and once the language difficulty is overcome a far juster estimate of their character can be made. The author of this book was brought up in close contact with the Aranda, able not only to speak their language, but even to think in it. He is able, therefore, to describe their ceremonies and transcribe their chants and folk-tales accurately and feelingly, combining the point of view of the participant with that of the observer. Some previous students of the Aranda have not realized the extent to which the northern, western and southern divisions varied from each other, so that little generalization can be made as to customs and ceremonies as a whole. But by limiting the study to one area (in the first section of the book the northern Aranda area in Central Australia) the author is able to give a reasonably full account of the myths and religion of a strongly patriliniar group.

These myths are mostly brief accounts of the lives of totemic ancestors handed down by word of mouth by the old men to young initiates, usually on the occasion of a visit to the local spot where the *tjurunga* or sacred sticks and stones are hidden. By the power of their superior knowledge, the old men hold absolute authority in all matters of religion and custom, and there is no outlet for any creative impulse in the younger generation. Every possible site in the territory has already been assigned its own spirit or myth, and there is nothing left to the young men but to follow the traditions of their elders—a stultifying state of affairs.

Mr. Strehlow gives a detailed account of the visit of initiates to one of these sacred caves, an account which recaptures the spirit of the occasion, and he follows this with a number of northern Aranda myths. It is interesting to see various threads running through them all, or at least through the majority. For example, the manner of origin of men from their totemic ancestor, in these cases so 'patrilinial' as to dispense altogether with any female intermediary, the sons being 'born' from the armpits of the father, as if the original inventors of the myth were unwilling to admit any possible claim on the part of women. Another point which is brought out is the hostility between the original father and his sons, leading to gross cruelty and frequently even to cannibalism.

The second part of the book deals with the three Aranda sub-groups already mentioned, distinguishing the customs of each group, especially those connected with *tjurunga* and initiation ceremonies.

The third part is concerned with *tjuruŋga* ownership, quarrels about which were frequent during the performances of the sacred ceremonies. The term *tjuruŋga*, as differentiated from *tjurunga*, is very indefinite and covers at least eleven different items, objects of stone or wood, sacred ground paintings or even sacred chants. In this section the author gives concise accounts of initiation festivals and also details of the laws governing *tjuruŋga* ownership.

The photographs illustrating the book are rather small and not very clear, but nevertheless give a good impression of the scenes they portray. The book itself is a valuable addition to our rather exiguous knowledge of this interesting and diminishing race.

K. Rishbeth

ALTERNATING-CURRENT POWER TRANSMISSION

Le grandi linee di trasmissione d'energia

Calcolazione elettrica. Per A. Dalla Verde. Pp. xi + 386. (Milano: Cesare Tamburini, 1947.) 1700 lire.

At present, the all-important problems of power transmission are those relating to long-distance energy transport and interconnexion of high-power networks. Examples of the first class are transmission from Norway to the Continent of Europe or to Great Britain, from the Victoria Falls to the industrial areas of South Africa, from Tasmania to Australia, from the Lower Danube to Central Germany. In the second class the realization of a European Grid system is the most imminent.

Quantitatively, these problems resolve into the transmission of total powers of the order of 1,000 to 3,000 MW. over distances of 600 km. and upwards. Transmission by alternating current at high voltage is the method which has been most fully developed. This system has become commonplace at voltages up to 220 kV. The maximum voltage at which extensive practical experience is available is 287 kV.—the voltage used for transmitting power from the Boulder Dam to Los Angeles. Sweden is constructing a 380 kV. power line more than 600 km. long, and a 220 kV. line in France has been designed with the view of facilitating its conversion to 400 kV. in the future. In progressing from 287 kV. to 400 kV., detail problems relating to the conductors and insulators have to be examined, such as corona losses, and transient voltages arising from switching or from natural causes.

Costs of transmission lines and apparatus rise so rapidly with voltage that every component has to be examined with the view of attaining maximum overall economy. The costs of the transmission lines themselves are so great that there is also incentive to study alternatives to the established three-phase, 50-cycle systems, such as D.C. transmission.

These generalities should make it evident that new authoritative work on electrical transmission is worth serious examination.

The appearance of an Italian treatise is specially opportune as Italy has done much individualistic pioneer work in electrical transmission at very high voltages, in conditions which demand the closest attention to economy. The volume under review deals with alternating-current transmission in seven main sections: fundamental line constants, electrical calculations of line characteristics, vector and circle diagrams, voltage regulation, static and dynamic stability of three-phase systems, and choice of the fundamental elements of a transmission system.

Two appendices—hyperbolic functions and symmetrical components—give an easy review of the mathematical aspects of the subject.

The treatise is remarkably clear and objective, and in the reviewer's opinion takes a very high place among works of the kind. There are minor blemishes in printing, and some of the illustrations are difficult to decipher; but on the whole it is a pleasure to read the book. It covers adequately all electrical aspects of alternating-current transmission, and enables any conscientious reader to design a high-voltage transmission line which would be both safe and economical. Even with the best guidance from books, it has to be recognized that special tests must be made on site before finalizing designs of transmission lines. Two examples illustrate this point. In the case of 70 kV. lines erected more than twenty years ago on the coast of French Morocco near Casablanca, early experience showed that no normal type of insulator would withstand the salt-laden atmosphere which provoked flash-over on such a scale that it appeared probable that the transmission project would have to be abandoned. A remarkably bold and successful solution was found by the local engineers, who improvised oil-filled insulators which saved the situation.

The second case is that of the British 132 kV. Grid lines, which were originally insulated in accordance with the requirements of the empirical formula $(U/15 + 1)$ = number of disks per chain recommended by Signor Dalla Verde. Even with 20 per cent additional insulation, which was provided for in the mechanical clearances, flash-over troubles were so prevalent during fog in industrial areas that the degree of continuity of supply was altogether inadequate. In this case the situation was saved by the use of specially shaped anti-fog insulators which a British firm had developed. The lesson to be deduced is that experience at lower voltages in Great Britain and at the same voltage in other countries proved insufficient warning of the electrical difficulties arising from our peculiar atmospheric conditions.

It is to be hoped that engineers will have an opportunity of bringing to reality some of the projects mentioned at the beginning of this review. Young engineers who may be interested in them could find no better guidance than that provided in Signor Dalla Verde's book.

C. W. Marshall

Chymia

Annual Studies in the History of Chemistry. Tenney L. Davis, Editor-in-Chief. Vol. 1. (Edgar F. Smith Memorial Collection, University of Pennsylvania.) Pp. xiv + 190 + 16 plates. (Philadelphia: University of Pennsylvania Press; London: Oxford University Press, 1948.) 3.50 dollars.

THIS handsome volume, which is a worthy memorial to the late Prof. Edgar F. Smith, well known for his publications in the field of the history of chemistry, contains fourteen articles covering various aspects of the subject. All but one are in English. After a foreword, the essays take up the subjects of Frederick Accum, C. A. Browne, an English alchemical poem, Thomas Thomson, French chemists about 1840, Mendeléeff, potassium chlorate in pyrotechny, the early history of calomel, the concepts of substance and element, the water controversy, Scottish alchemy, the Karlsruhe Congress, and Dulong. There are several plates, and the text is unusually well printed, which, with the attractive binding, makes it a pleasure to read the volume. It is proposed to issue a volume annually, and if further volumes are as good as the first, the editor-in-chief, Prof. Tenney L. Davis, whose own historical publications set a very high standard, may well feel satisfied. All concerned in the production deserve the thanks of chemists who are interested in the history of their subject. The series should be acquired by all chemical libraries, and is a notable contribution to scientific literature.

Chemical Synonyms and Trade Names

A Dictionary and Commercial Handbook. By William Gardner. Fifth edition, revised and enlarged by Edward I. Cooke. Pp. viii + 558. (Kingston Hill: Technical Press, Ltd., 1948.) 50s. net.

THE only satisfactory method of reviewing a reference book such as this is to make continued use of it over a period of time, for only in that way can its value really be determined. Following this course, the reviewer has been surprised at the frequency with which trade names turn up during the course of a day, and has been equally surprised at the completeness with which the dictionary has met all demands made upon it. Only very occasionally has it failed; for example, it makes no mention of sulpha drugs, such as sulphapyridine; but the constancy with which it succeeds makes its failure a notable event.

The book will prove of great value to all who have to deal with chemistry and chemicals, and its information is not confined to any particular field of chemistry but embraces all. It is well printed on good paper and is stoutly bound, as a reference book should be.

Organic Syntheses

An Annual Publication of Satisfactory Methods for the Preparation of Organic Chemicals. By R. L. Shriner, Editor-in-Chief. Vol. 27. Pp. vi + 121. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1947.) 13s. 6d. net.

TO the large number of organic chemicals for which reliable preparative methods have been given in this invaluable publication a further list of thirty-nine is now added. As typical examples may be mentioned 3,5-dimethyl-2-cyclohexen-1-one from acetaldehyde and acetoacetic ester, ethyl α-isopropylacetoacetate from isopropyl alcohol and acetoacetic ester in presence of boron fluoride, 3-penten-2-ol from magnesium methyl chloride and crotonaldehyde, stearolic acid from methyl oleate, and tetraiodophthalic anhydride from phthalic anhydride and iodine in presence of fuming sulphuric acid. The statement of directions and precautions, the bibliography for each preparation, and the printing of text and formulæ are all admirable and remarkably free from errors. The cumulative index covers volumes 20–27.

J. R.

The Rare-Earth Elements and their Compounds

By Prof. Don M. Yost, Horace Russell, Jr., and Asst. Prof. Clifford S. Garner. Pp. ix + 92. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1947.) 15s. net.

THIS little book on the elements of the rare earth group, or lanthanides as they are now called, contains chapters on (*a*) electronic structures and oxidation states, (*b*) magnetic properties, (*c*) absorption spectra, (*d*) evidence for the existence of element No. 61, (*e*) separation of the rare earths, and (*f*) chemical and physical properties of these elements. There is also an appendix on nuclear properties of the rare earth elements. Since the chapters noted above cover only 69 pages, it is inevitable that the subject-matter has been very much condensed, a fact more evident in descriptions of chemical than physical properties. Apart from this limitation, the volume contains much useful and interesting information about this group of elements. The rare earths have received more attention from chemists following the discovery that some of them are formed directly or indirectly in nuclear disintegrations. This book provides a useful introduction to the study of a very interesting series of the chemical elements.

Elements of Nomography

By Prof. Raymond D. Douglass and Asst. Prof. Douglas P. Adams. Pp. ix + 209. (New York and London: McGraw-Hill Book Co., Inc., 1947.) 3.50 dollars.

THAT a straight-edge laid across three coplanar linear scales will serve to express a multilinear functional relation between the indicated scale readings is obvious; if the linear scales are not uniform, more complex relationships can be dealt with. But the step from these simple ideas to the construction of the alignment charts used increasingly in engineering, industry, business and other fields is considerable, and demands skill in design and draughtsmanship as well as in orderly computation. Profs. Douglass and Adams are anxious that the young nomographer should not try to run before he can walk, that he should realize "how small a portion of his entire problem the theoretical solution represents". Thus they begin with a painstaking discussion of scales, occupying six chapters, before starting their discussion of the simpler alignment diagrams in a series of nine short chapters, the last of which deals with the hexagonal diagram for the relation

$$1/x + 1/y = 1/z.$$

There is a short chapter on the use of a circular nomogram for the relation $xy = z$, and a final lengthy chapter on a variety of more complex alignment diagrams, wherein curved scales are employed.

The casual reader who merely wishes to learn a little about nomograms would probably find the pace of this book too slow. But a novice with some strong incentive urging him to master the topic should profit from the careful and detailed discussion, with its valuable practical illustrations.

THE ROYAL SOCIETY SCIENTIFIC INFORMATION CONFERENCE

Introduction

THE Scientific Information Conference held by the Royal Society during June 21–July 2, which was attended by about a hundred and thirty delegates from organisations in the United Kingdom and thirty from the Overseas Commonwealth and the United States in addition to about a hundred observers, was the outcome of a recommendation passed by the Royal Society Empire Scientific Conference of 1946 to examine, in this way, the possibilities of improvement in existing methods of collection, indexing and distribution of scientific literature and of the extension of existing abstracting services.

The importance of the questions involved arises from the overwhelming mass of the literature, which is estimated to total anything up to one million published items a year, apart from the unpublished reports and memoranda which multiply within every scientific establishment and may locally be even more important. This makes it impossible for any individual to scan more than an infinitesimal fraction of what currently appears even within a limited field, or to be sure of finding retrospectively those references which are the most apposite to his own work, unless the indirect means of doing so are highly organised.

Various aspects of the problem have, over many years now, been receiving attention on behalf of the scientific worker through such bodies as ASLIB (a union of the Association of Special Libraries and Information Bureaux with the former British Society for International Bibliography), the International Federation for Documentation, the British Standards Institution and latterly the Technical Information Services Panel of the Committee on Industrial Productivity appointed by the Lord President of the Council. Much useful discussion is to be found in the published proceedings of the first two of these organisations; but along some lines of development—as, for example, mechanical methods of selecting literature references—the position reached is that inventors of machinery and documentary devices have progressed ahead of the ability of the users to tell them what they actually want done. Hence the value of a conference representing primarily the beneficiaries rather than the organisers of information services, and particularly of one at which the special problems that beset scientific men working at isolated posts overseas could receive their due share of attention.

The Conference was organised in four sections to appreciate and discuss what can be done to improve and rationalize the arrangements for:

(1) Publishing and distributing original scientific papers (Editor: Prof. J. D. Bernal).

(2) Issuing and using abstracts to convey current awareness of the availability and relevance of such papers (Editor: Sir David Chadwick).

(3) Consolidating abstracts or other forms of reference into continuously cumulative indexes and using these and other library services for the retrospective searching of the literature (Editor: Dr. J. E. Holmstrom).

(4) Producing and utilizing periodical reviews of progress in designated fields of science (Editor: Prof. H. Munro Fox).

The editors were appointed some months beforehand to take charge of each of the four sections, and they had, with assistance from others, prepared much material for consideration. Terms of reference had been drafted for forty-two specific subjects of study by sixteen working parties. At the opening plenary sessions of the Conference the background to these questions was explained by the editors and the membership of the working parties was made up, each consisting of six to eight persons having special knowledge of the groups of questions they were to answer. In some cases panels of consultants were also listed from which the working parties could co-opt additional members when considering particular questions. The working parties then met separately—except for a few joint meetings where the interests of several overlapped—until the final plenary sessions, when their conclusions and draft recommendations for action on each question were reported to the Conference as a whole for adoption, amendment or rejection. In this way altogether some seventy recommendations were finally sent forward by the Conference to the Royal Society, proposing positive actions either by the latter directly or through appropriate named organisations.

Section 1: Publication and Distribution of Papers Reporting Original Work

Section 1 of the Conference had to deal with the publication and distribution of papers containing reports of original work. Papers referring to this prepared for the Conference were essentially of two kinds: those setting out suggestions or expressing opinions, and those containing numerical and statistical information on publication and reading habits. In the first category were the group of papers on Prof. J. D. Bernal's proposed scheme for centralized distribution of scientific papers, criticisms of it by the Physical Society and by the editors of some biological societies, and comments on these views. In the second category were studies on the average length and scatter of papers in different periodicals, on the variety of formats in journals taken at the library of the Royal Botanic Gardens, Kew, on delays in publication; and lists were prepared, after consultation with societies, of the chief journals published in different fields in the United Kingdom and the Commonwealth.

In addition to these, the results of two surveys, one organised by Mr. Urquhart on papers inquired for at the Science Library, and the other of a special questionnaire sent out to research workers in Cambridge, the Department of Scientific and Industrial Research, Rothamsted Experimental Station, the Medical Research Council and various industrial firms. The steering committee of the Section eventually drew up a set of terms of reference for five working parties:

Working Party I/A: (i) To examine the present format of scientific publications and to make recommendations as to the adoption of suggested standards. (ii) To review methods of reproduction of scientific papers and to make recommendations as to the applicability of each.

Working Party I/B: To study the importance of editorial distribution and other factors in relation to the length of scientific communications and to make recommendations as to any desirable changes.

Working Party I/C: To consider whether any advantage would be gained from a more rational subject grouping of scientific communications within existing journals.

Working Party I/D: To consider the general question of the organisation for publication of original papers and the mechanism for their distribution, and to recommend any steps which may be taken through the co-operation of existing bodies towards achieving any desirable improvements.

Working Party I/E: (i) To examine the present causes of delay in publishing original scientific work and to make recommendations. (ii) To review existing difficulties in the availability of scientific information to men of science, and to make recommendations.

In order, however, to give greater coherence to the work of the Section, the first and last meetings of 'working parties' were joint working parties, and joint meetings of working parties of different sections were arranged on the subjects of photographic reproduction methods and classification.

At the opening plenary session on June 21, with Sir Alfred Egerton in the chair, short statements were made by the editors and the leaders of the working parties and a general discussion followed, with the purpose of conveying to the 'working parties' the views of the members of the Conference. On June 23 there was a special plenary session to consider the replies to the questionnaire already referred to, and to another sent out by Sir David Chadwick on abstract services.

The major conclusions of the questionnaires were of a very decisive character and modified considerably the type of proposals put before the Conference. The most important of these results was that emphasizing the large reliance of research workers on libraries, principally departmental libraries, three-quarters of their reading being derived from this source and the relatively small proportion of reading derived from journals subscribed to by the research workers themselves. It would appear that the average research worker looks through some nine papers a week and reads three carefully, making notes and usually keeping a card index. The paper was read, in 37 per cent of the cases, on account of a reference in another paper and only in 18 per cent on account of an abstract. Reprints furnished 6 per cent of the general reading, but 12 per cent of the careful reading. There were some significant differences between the reading habits of the different sections, those in the applied sciences reading on the whole fewer papers than their more academic fellow workers, and senior workers looking through more papers, but reading fewer carefully, than junior workers. The distribution of reading in various journals was significant: 2,000 papers described as carefully read during the course of the inquiry were derived from 430 different journals; but the distribution of papers consulted among journals varied enormously, one-quarter of the papers being found in six journals, half in thirty, and the last quarter in 330 different journals. This emphasizes a law derived by Bradford from studies of the actual distribution in journals of papers covering particular topics, and shows that his conclusions apply equally strongly to papers actually read. It is also notable that more foreign papers were read than British, and that the great majority of these were American. The major conclusion that can be drawn from these results is that, in the absence of any rational system of distribution of papers by subject, the libraries are the essential agents in the distribution of scientific publications.

The 'working parties' each held a number of meetings which were on the whole remarkably free from controversy, and came to conclusions and recommendations for the most part unanimously. The position of working party I/A was fortunate in that its chairman, M. Lemaitre, had just returned from a meeting of the International Standards Organisation at Geneva and was able to refer the Conference to resolutions already taken on the standardizing of the format of periodicals. The advantage of a limited number of sizes was admitted, and the resolution passed that once these standards were accepted societies would be urged to adopt them whenever they were changing their format. Similar considerations were given to the layout, particularly on such questions as the form of reference and the desirability of beginning each separate paper on a right-hand page to facilitate the issue of reprints and the division of the journal into papers for reference purposes. On questions of reproduction, it was agreed for the most part that printing is the most suitable for large numbers, but that new methods, particularly lithography and the diazo reflex process, might be increasingly used when small numbers are required. The 'working party' put its weight behind the general recommendation for further research on, and development of, methods of reproduction.

'Working party I/B' was on much more controversial ground in its study of the lengths of papers. While there was general agreement that too many papers of a repetitive nature are written, and that papers are longer than they need be, results incorporated in the general resolution of the Section, there was more discussion on the suggestion of extending the practice, already adopted by the Institution of Electrical Engineers and some other bodies, of issuing with the journal a full précis of a length from one-twentieth to one-quarter the original length of the paper, to be issued together as précis-journals covering a cognate group of sciences. The argument for such précis-journals was that they would provide digests of material lying outside the immediate field of any particular worker which would not, in fact, be read unless presented in this shortened form. The argument against it was that the proposal involved the issuing of still further publications and that the field would be covered as adequately by informative abstracts. The 'working party' finally agreed to put forward the suggestion for consideration by the proposed consultative committees of editors suggested by 'Working party I/C'. 'Working party I/B' further considered the need for making provision for the preservation and permanent availability on demand of copies of scientific documents and reports which are too long for publication in the ordinary way. It recommended that some system of deposit similar to that of the Science Service in the United States should be established.

'Working party I/C' was concerned with the grouping of scientific communications within existing journals. This question is very closely connected with that of the classification of science considered more particularly in the other Sections. It was recognized that the scatter of papers on essentially the same subject in journals is very wide; but the 'working party' did not feel competent to indicate precisely how it should be reduced. It is suggested, however, that this could best be done by the setting up of standing consultative committees of editors in cognate subjects, as is already the case for the Biological Council. These editors might by negotiation arrange among themselves what subjects fell properly within the scope of the particular journal, and which might equally well appear in a small number of journals. In the latter case some provision of exchange of lists of forthcoming papers might present the reader of any particular journal with information as to what is going on in his field far wider than he gets from the journals he can take and far more rapidly than he can get from abstracts. This 'working party' also considered the whole question of the formation of new journals or the extension and division of old ones. It concluded that the latter procedure is on the whole preferable, and that in any event it should not be penalized through the present control of paper supplies.

'Working party I/C' also dealt with two other questions of a more financial nature. It is clear that additional functions for editors, together with the responsibility of producing a paper in a better form (discussed above), would increase the work laid on them. It was recommended that means should be found to provide secretarial and other assistance to editors of journals, particularly smaller journals. The weak financial position of nearly all publishing bodies is clear from the proposal to extend the practice already prevalent in the United States of asking authors to pay for insertion of papers in journals; this was supported by the 'working party' only in exceptional cases, while the Conference itself by a decisive vote was against requests for payment in any circumstances. This, of course, leaves the position exactly where it stands, and if rising costs are not to mean actual restriction of the amount published without regard to quality, the only solution can be through increased grants, either direct from Government or by some form of levy.

'Working party I/D' dealt with the very wide question of organisation of publication of original papers and mechanisms for their distribution. It was originally thought that this working party would deal with the detailed proposals of Prof. Bernal on reprint circulation; but as he himself (as he explained), in the light of the questionnaire on the subject, considered that distribution through libraries is far more important than distribution to individual research workers, this did not come up for discussion. Instead the 'working party' concentrated on the means of obtaining separates directly from publishing bodies or by subsequent copying. The resolution as finally passed by the Conference, after emphasizing the importance of separates to scientific workers, called for a special exploration of the possibility of societies, libraries or commercial enterprises acting as agents for obtaining and distributing such separates. The question of copying separates, which is widely practised in individual cases, came up under the general question of copyright, at a special discussion at the Conference. 'Working party I/D' also emphasized the importance of library and information services, and particularly stressed the need for immediate Government action to provide for the enlargement of central scientific libraries and information services, and for providing for the effective functioning of these by an adequate staff having special qualifications in librarianship and science. It here made special reference to the Patent Office Library, the space in which has not been increased for many years, and to the Science Library. To increase the effectiveness of libraries it also proposed that library committees should co-operate to a greater extent than at present to prevent duplication.

'Working party I/E' had the task of exploring delays in publication and the availability of already published scientific material. It came to the conclusion that the best way of eliminating the former was by closer co-operation between the printing trades and the scientific societies, and in a resolution called on the Royal Society to organise a permanent liaison committee between industry and scientific publishing bodies. The technical means of more rapid publication by alternative methods, particularly lithography, were discussed and the matter referred to a proposed standing committee on the development of reproductive methods (referred to below). Another point stressed by this 'working party' and incorporated in the general resolution of Section 1 was the need to increase the speed of every stage of the process of the production of a scientific paper, beginning with its actual writing, and passing through its examination by heads of departments, its refereeing and the various stages of actual reproduction and correction. Delay at any stage was felt to have a psychological effect, increasing the probability of delay at other stages. As to availability, particularly in the Commonwealth, this matter was felt to be very largely one of discovery of the whereabouts of the material, and therefore depended on indexing and abstracting. Here proposals for the preparation of lists of titles and abstracts, particularly those emanating from Dominions and Colonies, were made and incorporated in other resolutions of the Conference.

In the general meetings of the Section many points were raised by different 'working parties' so interrelated as to make it desirable to include them in one general resolution. It was proposed that the Royal Society should initiate a vigorous and sustained campaign to improve the preparation and presentation of papers. This would involve action all along the chain of preparation, beginning with the research worker himself, who should be better trained than at present in the technique of writing and preparation of papers for publication. In turn, directors of research might be able to save very much editorial time and trouble at a later stage by careful pre-editing. Editors themselves, or the publication committees of their journals, were urged to take a more severe line than at present on the acceptance of papers for publication, eliminating so far as possible those that were merely repetitions with variations of papers appearing elsewhere, or those lacking in brevity or clarity of expression.

The recommendations of the 'working parties' were communicated to the plenary session of the Section on June 29, where they were subjected to lively but on the whole friendly discussion. They were for the most part, after certain amendments, accepted by the Conference as a whole, the only point of dispute being the question of the proposed précis-journals which, being a relatively new idea, certain of the delegates would have preferred to be omitted altogether from the resolution.

The full bearing of the recommendations of Section 1 can only be fully appreciated in relation to the general work of the Conference; but it may be claimed that although no radical changes were proposed, the sectional recommendations indicate in a precise manner what should be done by other bodies to improve the production and distribution of original scientific material. The technical questions were appropriately referred to representative committees which have some reasonable chance of getting their recommendations accepted. On the more general issues of improved distribution of reprints and a more concentrated and more rational grouping of papers in journals, much will depend on how far it is possible in practice to set up effective working committees of editors who, with the greatest knowledge of their respective subjects, will be most able to set their particular house in order. It is to be hoped that members of scientific societies will also, as a result of the Conference, take more interest than they have in the past in the mechanism of publication, realizing that it is in their own hands to modify, and that it is not some divinely imposed order which they must accept without complaining.

J. D. Bernal

Section 2: Abstracts and Abstract Journals

On the shelves of the Athenæum Club is a series of annual volumes, politely styled, "The Works of the Learned". The date of the first is 1699. They are informative abstracts, longer than those now usual yet true to type. Abstracts of scientific papers are certainly not new. Yet the decision of the Royal Society to devote one main section of its Conference to the consideration of abstracts and abstracting services is likely to prove timely.

The keynote of the Conference was service to science and to the scientific worker. Abstracts exist to serve the scientist. That is their sole justification. The English-speaking peoples are the chief producers of scientific abstracts. The journals of some of the United Kingdom abstracting services have appeared without a break for more than seventy years. The number of those services has increased markedly in the last twenty to thirty years. Yet this Conference was the first occasion on which representatives of most of those services had met together as a group to consider how far they were serving the needs of science as a whole, how their methods and techniques agreed or differed and in what respects such variations detracted from extended use of their journals and labours. What also was most certainly new was to have available at such discussions the assistance and criticism of scientific workers of most varied interests and of representatives from the Dominions overseas, from the United States and from the United Nations Educational, Scientific and Cultural Organisation. This alone ought to make this Conference worth while in the long history of abstracts; but what was really surprising came out in the early days of preparation for the Conference, namely, the almost complete lack of factual information about the existing abstracting services, and of how scientific men, in their differing circumstances and in their different branches of science and its applications, actually used abstracts and for what purposes. Was their chief purpose to provide 'current awareness', making speed of issue the prime requisite and their useful 'life' comparatively short? Or were they often consulted over periods of five, ten or even twenty years, in which event obviously good subject indexes, and where possible consolidated five- or ten-year indexes, were a great advantage? Was it broadly true that while an informative abstract is invaluable to the scientific worker far from a good library, as one working in a Colony, the indicative type of abstract generally meets the needs of anyone in the United Kingdom? Precise answers to such questions must vary in different branches of science, but are enough facts known to afford any general guidance or lead to abstracting agencies as a whole?

Opinions were numerous on how abstracts should be written, how indexed, on their type, on their excellence in some cases and failures in others, on their 'gaps' and 'overlaps' and on the difficulties in borderline subjects; but facts were few. This was inevitable, for surprising though it may seem, no list of the abstract journals published in the United Kingdom was readily available; consequently, no ready information on the branches of science and of its applications they, as a whole, presumed to cover. It is not suggested that any scientific men could or would have occasion to refer to all the abstracting journals. He knows one or two, and may at times be referred by his librarian to others; but if no ready information of their general coverage is available, he can scarcely be expected to refer to a journal the title of which may be vaguely familiar to him although he may be ignorant of its scope. The plight of a scientific man overseas wishing to use United Kingdom abstracts is greater.

Factual information had been collected from many of the abstracting agencies. This was presented to the Conference in condensed form, also the results of some inquiries into the use of abstracts. The Conference, however, realized broadly how the present services had grown up, their general character, the experience gained and knowledge orderly accumulated. It referred the whole subject to three 'working parties'; one to examine the place of abstracts in the service of scientific workers, their relation to other forms of service, such as reviews, bibliographies, etc., and to review the existing services; a second composed mostly of representatives of the abstracting agencies to compare their methods, techniques and practices; and a third to look to the future.

A paper presented by the Science Library, London, showed that notices in abstracts probably cause most inquiries for copies of original papers (possibly a third of the total), closely followed by references to papers in other papers. Prof. J. D. Bernal's pilot survey in Cambridge and elsewhere placed it lower at one-sixth. A small-scale but very welcome voluntarily organised inquiry in the University of Birmingham showed a preference of more than three to one for informative abstracts, and that about one-third of new papers were discovered through abstracts. Other information suggested that informative abstracts were more used in the United Kingdom than might have been thought. But all these inquiries were on too small a scale to give any reliable indications. Also, to be useful, they would need to be broken down according to the different branches of science and its application. A diagrammatic representation of the inter-relations of science and the scope of existing abstract agencies which Dr. H. J. T. Ellingham had prepared showed at a glance present gaps and overlaps. Gaps, time-lag and indexing were the chief subjects of complaint.

One fairly recent change in the type of user came out, arising from the extended use of science in organised industry. This is the increased reliance of many scientific workers on the 'information officer' for help in searching and in obtaining literature. The information officer thereby becomes another and constant user of abstract journals. Also, such are the extensions of the use of science in industry that many abstracting agencies may not have included these officers as users of their journals. Abstracts have always been designed to serve particular groups of scientific workers directly, and the various abstracting services look on their work from that angle; but as this tendency extends, consideration of the needs of these information officers as potential users of their journals becomes important.

As regards the abstracting services, the facts collected brought out several points. Most of the published abstracts are of the informative, that is, longer, more detailed, type. *British Abstracts*, the largest single service, are of the brief, or indicative kind. Nearly all are on a non-profit earning basis. This means that behind each is some sponsor society or department. It thus follows that the phrase 'abstracting agencies or services' cloaks many variations of functions or duties. The functions of any agency are those laid down or approved by its sponsor society or department. These may be confined to the preparation and issue of abstracts, as with *World Abstracts of Medicine*; or, as with the Tropical Diseases Bureau and the Commonwealth Agricultural Bureaux, they may be those of centres of information entailing aid in preparing reviews, in obtaining reprints or copies of papers, or translations or even in identifications. The issue of the abstract journal then becomes one of several duties and not a sole function. The agencies are not thus all of one type or origin, capable of easy recasting or reshuffling. They differ in function, type, scope and finance. But they all have this basal characteristic in common: each has been called into being at the instance of scientific men, engaged in some branch of science or of its application, to serve their particular needs; each is responsible to (and ultimately controlled by) scientific men in its sponsor society or department.

In each case responsibility for the abstract journal rests on scientific workers trained in that subject. Control may become difficult in particular cases; but the identification of a service with those engaged in a particular branch of science or of its application should foster service of a type suitable to its needs and the maintenance of quality and accuracy. This identification of a service with a particular group carries a corollary. The primary loyalty or allegiance of any abstracting agency is to the scientific workers in its sponsor society or department. The Conference showed no desire to disrupt such associations, or to subject them to outside authority, for the sake of a general uniformity. To have done so would have been to ignore differences between the needs of different branches of science, and the fact that in some agencies overseas interests are active participants; yet an indefinite increase in the number of isolated independent services must lead, in the ever-increasing inter-relationships of science, to overlapping and confusion rather than to clarification. Responsibility to a particular group or branch is in no way incompatible with better service to science as a whole. The operative portions of the Conference's terms of reference to the third working party, that looking to the future, were then: "To consider and report, with recommendations if desired, on the advisability, cost, organisation and functions for a Council on Abstracting, not to centralize all abstracting, but as a continuing agency, to promote co-operation between abstracting services, the elimination of gaps . . ."

It was with this background of facts and ideas that the 'working parties' started on their labours. It was impossible in the few days at their disposal to solve definitely all the points which arose. This was especially so in the second 'working party' where, for the first time, abstracting agencies had met to examine their methods. Differences undoubtedly existed. To adjust those so as to secure a wider use of their journals is a continuing task and not one to be settled in a few preliminary meetings. They therefore presented their findings to the Conference chiefly in the form of conclusions, rather than recommendations. The first 'working party' also presented most of its findings by way of conclusions. The conclusions and recommendations were placed later before the Conference, were discussed, passed, amended, or rejected by it. The leaders of the three 'working parties' were Dr. H. G. Thornton, Mr. B. Fullman, and Dr. G. M. Findlay; the recorders Dr. M. A. Vernon, Mr. J. Beak and Dr. B. M. Crowther. All 'working parties' had the help of representatives from the countries overseas and from the United States. Mr. J. B. Reid, of the United Nations Educational, Scientific and Cultural Organisation, brought to Working Party No. 3, looking to the future, the latest information on international developments.

The conclusions reached by the Conference should, if followed, improve the general usefulness of abstracts. A few only can be mentioned here. Some overlapping between abstract services is desirable, when the services cater for readers having different interests. Such overlap is distinct from duplication. For this reason a single set of abstracts produced by a central agency would not suffice for universal use. Publication of abstract journals, covering identical fields and directed to the same type of user, constitutes duplication and is to be deplored. The quality of abstract indexes is frequently unsatisfactory. Abstracting services, unless combined with an information service, as is often desirable, cannot be expected to answer specific inquiries on literature. By way of comment on this point, it may be explained that this conclusion merely reflects the differing functions of these services, as already explained. All realized that the usefulness of abstracts is gravely impaired if the means for obtaining copies of the original papers are inadequate. This question kept reappearing in all sections of the Conference, and is undoubtedly one of prime importance.

Among the recommendations was a strong emphasis on the need for comprehensive subject indexes to be provided with each volume; and a recommendation that consolidated subject indexes be provided at intervals. But the chief recommendation adopted by the Conference was that on co-operation in the future. It was to the effect that the Royal Society be invited to consult the abstracting agencies to set up a standing consultative committee of abstracting organisations for mutual exchange of views and generally to promote co-operation. The Committee should consist of representatives of bodies responsible for the production of journals of abstracts. It should work on a voluntary basis and the cost be kept low. Among earlier matters for its attention were listed, increasing uniformity in the services in the methods of bibliographical citation, the maintenance of a comprehensive list of journals of abstracts, the question of its publication and the possibility of including in it an indication of the general scope of each journal, the possibility of co-ordination of systems of indexing, the determination of fields where readers' needs are inadequately met, and the maintenance of a panel of abstractors with special linguistic knowledge.

If this standing committee is formed—and all the main abstracting services were in favour of it—many questions besides those tabulated will come before it, though those when worked out should greatly extend the knowledge and usefulness of abstracts. Not only will this be the first time that these agencies have met to exchange information and experience, but also such meetings and consultations will have a definite object, namely, to promote co-operation in the service of science generally. An aim has been given. This recommendation may thus become among the most constructive from the Conference in this Section. It is certainly timely, in the light of the increase in the number of these services, the increased efforts in applying science, the general stir for better organised dissemination of information and the revived interest of the possibilities of co-operation on the international level. On this the Conference, while recognizing the difficulties, urged organisations covering similar fields to make efforts at closer collaboration.

The conclusions and recommendations of the Conference in this matter of abstracts may not seem so wide or so drastic as some might have wished; but though much testimony was given to the utility of present services, the striking characteristic of the Conference was this—no question was approached from a particularist point of view. The obvious desire of all was to secure better service to the scientific worker; to build on what had been learnt, but to harmonize and adapt it so as to be even more effective in the service of science. The long history of abstracts to meet the needs of science is not closed—perhaps, indeed, a new phase is opening; the particular services will continue, for the needs of scientific men in different branches and in different circumstances must vary. But while preserving all that is most useful in that respect, conscious collaboration in the interest of science as a whole will constantly grow, so that the journals become more widely known, more easily used, borderline cases provided for, and needless diversities of practice eliminated.

In all this the visitors from overseas played an active and stimulating part. When discussing abstracting, the needs arising from one's own local conditions and circumstances are apt to be so prominently and even fatally in one's mind as to distort the conception of what must be in some degree a general and not an individual service. The overseas delegates helped to keep this needed balance.

DAVID CHADWICK

Section 3: Indexing and other Library Services

Whereas Section 2 of the Conference was concerned in securing awareness of current publications, Section 3 dealt with the provision for retrospective searching: the problem of how to dispose literature references in such a way that those among them which may help to satisfy any particular quest for information liable to arise in the future will be turned up, when the time comes, with certainty and speed.

This problem includes what is normally understood by librarianship, and also goes far beyond it in magnitude and complexity. A librarian in the traditional sense is occupied with the procurement, store-keeping and cataloguing of books as complete units; but not with analysing their contents or indicating their relevance. Yet a single book, journal article or patent specification may touch on many subjects and be important from many points of view; and the mere fact that a library which holds a copy of it has catalogued it under its author and title, or even under such multiple subjects as may be implicit in the title, goes only a very little way towards what is required. The problem of documentation is, in fact, to ensure that when a scientific man needs to find out what has already been done and thought regarding any topic whatever, he can quickly be given the most apposite references not only among the hundreds of thousands collected in his own departmental library but also among the millions available to him, by way of loan or photo copy, from the libraries of the world at large.

Any one of these may turn out to be the one which would best serve the interests of some future inquirer, if only he knew of its existence, by enabling him to begin his own researches from a more advanced starting point. There being no means, however, of foreseeing which item that will be, there are needed economical techniques for the mass processing of the greatest possible range of literature references to meet the contingency that any one of them may be of value. Fundamentally, there are four ways, each with its variations and its advantages and disadvantages, along which this central problem can be attacked:

(1) Indexing the names of subjects in alphabetical order. This is the usual system in books and at the end of each year's run of a journal; under certain conditions it is satisfactory also for card indexing. But it involves many more difficulties and moot points than are apparent at first sight. It has the effect of dispersing logically contiguous items according to the letters of the alphabet with which their names happen to begin, and as the names are not standardized so as to make them mutually exclusive, a searcher is liable to look in vain for something which the indexer has buried elsewhere under a synonym.

(2) Classifying the subjects themselves under symbols which serve to pinpoint their positions in a logically constructed map of knowledge. Many such classifications are in use, some locally for special fields of subject-matter and some general like the Universal Decimal Classification, which is an internationally standardized extension of the Dewey system developed by librarians for shelving books. On this system, knowledge as a whole is divided into ten primary branches each denoted by a first decimal number, each of these into ten subdivisions denoted by a second decimal, each of the latter into ten sub-subdivisions denoted by a third decimal, and so on to whatever degree of particularization is required. As the sequence of subjects is ideographic, not alphabetic, an alphabetically arranged key (corresponding to the gazetteer in an atlas) is necessary for locating subjects when only their names are known.

(3) Coding the subjects under symbols which can be represented by patterns of holes punched in a card, or by patterns of dots detectable by optical means alongside a microfilm of the document under reference. Items so coded can be stored in random order and run through a machine, when required, which automatically picks out those of them which have been coded in any particular way.

(4) Coding the shapes of certain classes of objects under symbols which can be treated as above. The Dyson and the Gordon–Kendall–Davison systems of chemical notation enable this to be done for the arrangement of atoms in a complex molecule, which makes possible the mechanical selection of references to chemical compounds according to their molecular structures.

As staff and resources for bibliographical work are limited, the application of any of these methods must be governed by a proper balance of time and effort between indexing or classification on one hand and searching on the other. The greater the chance of references of a given kind being of future interest, the greater the justification for the labour of analysing them minutely and of consolidating those of different dates and sources into a single cumulative index. Where, however, a subject is unlikely or seldom likely to be of interest, it is more economic to rely on making an *ad hoc* search if and when the occasion for it arises, even though this may involve the tedious job of consulting the separate annually published indexes of many separate journals in which references might be found. Elaboration of indexing is, in fact, an insurance, and just how big a premium it is worth must depend on circumstances.

Two of the working parties in Section 3, dealing respectively with classification and with mechanical methods, drafted recommendations which the Conference adopted on various practical aspects of this central problem.

The Universal Decimal Classification, it was held, has both advantages and limitations. Among its assets are the millions of existing references so classified and the many thousands being published every year with the class numbers already printed on them; these are among the justifications for continued extension in its use. But the criticisms to which it stands exposed were recognized also and led the Conference to favour setting up a standing committee for fundamental research into subject classification of science without pre-commitment to any particular system. Further study and research on alphabetical arrangement were also recommended.

Similarly a full-scale experiment on mechanical methods of selection was urged, as well as encouragement of the Aslib committee which is studying and collating progress in this field. A particular device, exhibited at the Conference, which the working party found of interest though no positive recommendations was made about it at this stage, was the invention of Dr. J. Samain of Paris: this has a typewriter-like keyboard whereby up to 24 six-letter words can be punched directly in a single card, and a selector able to pick out those cards which carry any desired word or combination of words regardless of the position or sequence in which these occur on particular cards.

On the question of chemical notation suitable for punching on cards, the Conference recommended that the attention which appropriate bodies are giving to one system be extended also to others proposed.

Another working party studied photographic and other new methods of reproduction. These have many important uses in bibliographical work, and the Conference recommended the establishment of an advisory committee to stimulate and watch developments in Great Britain and in other countries. As an example, it is an obvious economy if index items or abstracts which are required to be circulated sequentially in page form and also to be cumulated separately in card form can be reproduced in both forms without having to typeset or typewrite them (and check them) twice over. In the United States this is now widely practised. Another recommendation of the Conference which depends for its economy on suitable methods of reproduction was the issue from a central source of guide cards bearing Universal Decimal Classification numbers, for insertion direct into card indexes instead of having to copy them locally from a list. Again, in the United States the Library of Congress issues printed catalogue cards for all the books it handles, which hundreds of other libraries can use instead of having to do the work over again locally. Steps to develop such a service in Great Britain were recommended.

Among the new methods of reproduction studied and commended by the Conference was a Dutch process of diazo-printing (much cheaper than photography using silver chemicals) which enables not only direct copying from single-sided translucent originals but also, by a reflex method, copying from double-sided or opaque originals including the pages of bound books. This system has the further immense advantage that processing of the exposed paper is dry (or practically so) and therefore instantaneous, so that one or many copies of any document can be obtained, as and when required, in an ordinary office.

Various questions affecting the use of microphotography were studied, including the supersession of continuous lengths of film by strips or other more convenient units. Apart, however, from technical points like this, the great possibilities latent both in microphotography and in full-sized photo-copying for assisting the dissemination of scientific literature are governed more than anything else by restrictions resulting from the present copyright law. To give only one instance: if these could be removed by legislative reform, or circumvented by some form of agreement with authors' or publishers' organisations, the production and distribution of separate offprints of articles printed in journals would be greatly facilitated. The copyright question was discussed by the Conference at considerable length, and a recommendation was put forward stating the necessity for the provision of single copies of extracts from books and periodicals for purposes of scientific research and inviting the Royal Society to initiate action in the matter.

A fifth working party, which considered data tables, reference books and guides to information services, compiled a useful bibliography of these works. The Conference recommended continued action to ensure that scientific compendia in all fields of science were available and up to date, and to assist their publication where necessary. Financial aid to speed a new edition of the "ASLIB Directory" was urged, and a hope expressed that the "World List of Scientific Periodicals" might be re-issued as early as possible. The Conference recommended compilation of a British work corresponding to "Industrial Research Laboratories in the United States and Canada", and also of a subject index to the research activities and specialized knowledge of individual men of science.

Some 40 per cent of the world's scientific publications are in languages other than English; hence the importance of the questions referred to the sixth working party of Section 3, which considered translation services. As a result of its labours the Conference recommended greatly increased publicity for the ASLIB Register of Specialist Translators, which enrols only persons who combine linguistic knowledge with knowledge of particular branches of scientific or technical work; also its extension to those qualified to act as interpreters, by the simultaneous method, at international scientific conferences. Other recommendations included the institution of university or other suitable diplomas in translating and interpreting, the establishment of a central location index to unpublished translations, and that the Government be asked to consider action to modify the Berne Convention on international copyright so as to allow organisations such as the Science Museum Library to make available any translations deposited with them.

J. E. HOLMSTROM

Section 4: Reviews and Annual Reports

Reviews of a critical and constructive nature, written by leaders in particular branches of science, are of the greatest value, and senior investigators should regard the production of these as an important ancillary to the pursuit of new knowledge. The fields covered by critical reviews depend upon the first-class reviewers available at any given time. Such reviews, written by specialists, can be made very informative to workers in allied fields by the inclusion of an introduction and conclusion of a general, and as far as possible non-technical, nature. The desirability of the inclusion of the titles of papers in the bibliography of reviews and other scientific papers varies with the science; it is desirable in biology, possibly less so in chemistry.

Annual or biennial reviews, progress reports and books on recent advances serve a useful purpose, especially if prepared as critical reviews rather than synoptic summaries. Reviews written by specialists for workers in other branches of science are of great importance and at present are insufficient. In the applied sciences there is also a need for more review publications. In this connexion considerable material could perhaps be made available for publication by the larger industrial concerns.

Reports on 'symposia' are recognized as a valuable contribution to the recording of progress in science but are not a substitute for reviews or annual reports. A wider distribution of copies of the more important review lectures is desirable.

H. MUNRO FOX

THE PALESTINE FLORA

By ERIC HARDY

THE trouble in Palestine sets back the clock on the recent efforts of both Arab and Jewish gardeners to develop the horticultural attractions of the Holy Land, for the palm boulevards of Jaffa, and the flower-growing settlements at Mishmar-Hasharon, etc., had attracted much praise and attention. The danger, however, goes deeper, for modern Palestine was not the primitive wilderness of brigand and bedouin as depicted in most of the Western religious books. Several excellent gardens and plant collections were in the country, and their future is threatened by the bitterness of war. There is, for example, the best of the attempts to create a typically English garden, with its lawns and roses, its rockery and its pergola, which was in the grounds of Government House on the dry and dusty hill outside Jerusalem. On besieged Mount Scopus the botanical department of the University of Jerusalem housed the finest herbarium of the Near East flora, with more than 300,000 sheets of specimens collected not only in Palestine, but also in Syria, Arabia, Transjordan, and in particular the desert regions. There was also the private collection of Palestine and Transjordan plants collected in the American Colony in Jerusalem by J. E. Dinsmore, editor of the second edition of Post's "Flora of Palestine and Syria", where also the garden of a score of varieties of Palestine irises was a famous feature in April. Another internationally famous private herbarium, the largest outside the University, is the Herbarium Boyko, housed at the village of Talpioth, between Jerusalem and Bethlehem, in the home of Dr. Hugo Boyko, its compiler, an official of the Mandatory Government's Department of Forests.

At Rehovoth, which has been subject to several air raids, are housed the laboratories, collections, trial gardens, etc., of the country's main horticultural research. Here Dr. Oppenheimer, Dr. Samech and others maintained the vast organisation of the citrus research and the fruit-growing industry, where East Malling ideas were developed and plants acclimatized and tested. The horticultural edition of the *Palestine Journal of Botany* is produced here under Dr. Oppenheimer's editorship, while the purely botanical edition is produced at the University of Jerusalem under Prof. Zohary's editorship.

In recent years the University of Jerusalem had established a botanic garden on Mount Scopus, mainly for shrubs and trees typical of the country's flora, and including a coppice of cedar of Lebanon. Under the Mandatory Government, the Departments of Forests and Agriculture maintained several stations existing from Turkish times, like the vineyards, date palms and orchards at the old Turkish horticultural station in Jericho, and they established others. Near Acre the Mandatory Government established its main stock farm and horticultural and field crop station; its station for deciduous trees, carobs, vines and pruning instruction was near Safad. At Farawana, near Beisan, in the middle Jordan Valley, it had a station for sub-tropicals, olives, vines and dates; another near the historic Jacob's Well at Nablus for olives, vines and pomegranates; an experimental station for miscellaneous work was at Majdel, and a forestry station at Gaza that has been planting a large acreage of wind-blown sand with tamarisk to check the inroads of the Sinai sandstorms. From these stations, Arab gardeners were taught Western ideas of grafting and pruning, particularly for olive cultivation. The famous Arab olive orchards at Beit Jala near Bethlehem, and their pomegranate orchards near Ramallah, were a tribute to the work.

On the cool and fertile shores of southern Galilee, the Jews maintained a remarkably interesting nature study and agricultural institute called Beth Gordon, in memory of a pioneer settler, Aaron Gordon. This was at Degania settlement, in the vicinity of much of the recent fighting between Tiberias Jews and the Iraqi Army. Beth Gordon (or Gordon House) was open to any visitors interested in natural history or horticulture irrespective of membership. It maintained laboratories, lectures, a card-indexed library of 12,400 books in several languages, a museum with 18,500 animal specimens and a herbarium of 3,400 named plants, all under the direction of M. J. Palmoni. This was mainly a teaching centre, whereas Rehovoth was the main centre of horticultural research and plant acclimatization.

For several years the European colony in Jerusalem maintained a Jerusalem Horticultural Society, and in 1928 it published an instructive little booklet on the cultivation of gardens under those high, dry, chalky conditions. But war has sapped much of its energy and activity. The municipality of Jerusalem had initiated a few excellent little public gardens in recent years, gardens of begonias, *Lantana*, *Iris* and a strange mixture of Western formality and sub-tropical flowering shrubs, together with a small nursery for re-stocking these gardens, placed at the foot of the Mount of Olives.

It is true that in recent years Palestine-grown flowers were on exhibition in London and at Detroit; but Palestine has nothing to compare with Egypt's famous Gardens of the Nile near the Delta barrage. Jerusalem is a difficult place for the gardener, as its high position entails a seasonal variation from almost sub-tropical summer to winter snows and frosts. But since the mandate the temperature of Jericho in the hot lower Jordan Valley has been made much cooler for its inhabitants by the extended cultivation of trees, for both their floral effects and their fruit, irrigated with the sparkling waters of Elisha's spring. The first cultivators of the Jericho desert were the Greek monks, whose monastery orchards adjoining the tamarisk thickets just north of the Dead Sea are several hundred years old. In more recent years the Jewish settlement at Beth Ha'arava, beyond the recently destroyed Palestine potash plant on the north shore of the Dead Sea, 1,300 feet below sea-level, has cultivated a former salt-desert by leaching the soil with pipe-borne sweet water pumped from the nearby Jordan. The French Trappist monastery at Latrun, scene of bitter fighting for the Jerusalem–Tel Aviv highway, has developed some of the finest vineyards and orchards in the country, and its wines are nationally famous.

The main problem facing horticulture in Palestine was lack of water; but in recent years I saw how much of this difficulty had been conquered by the establishment of concrete aqueducts in the middle Jordan Valley, pumping sweet-water on to the Dead Sea salt-lands, and damming up by earth and concrete reservoirs the occasional but heavy winter rain that filled the wadis in the southern Negev desert. Artesian wells were much used in the coastal area, where practically all the great citrus-growing orchards were cultivated; but a generation or two ago, sandy wastes covered this area.

The pomegranate, the vine and the fig were already under cultivation by the native Arabs when the ancient Israelites first invaded the Holy Land. The Israelites introduced the apple, the first fruit to be mentioned in any historical writings, for Ramsis II had planted this native of the Black Sea in his gardens in the Nile Delta. The Jews traditionally introduced the citron to Palestine from their Babylonian captivity, and the Arabs are said to have brought the lemon and the orange to the Mediterranean coast from Iraq in the tenth century. Modern research into the history of the citrus fruits has, however, shown that oranges and lemons were known in Palestine in Mishnaic times, and the coins struck by Simon Maccabæus shortly after he conquered Jaffa in 136 B.C. show the citron was then in cultivation there.

The Western world has been indebted to Palestine for many of its irises. I have seen iris Grant-Duffii, the laurel and *Lilium candidum* growing wild in the Carmel area. The profusion of the garden anemone, *A. coronaria*, *Cyclamen persicum*, *Tulipa montana*, *Narcissus Tazetta*, the golden *Sternbergia aurantiaca* and of *Cistus* shrubs has borne offspring to grace countless gardens in Europe and America.

OBITUARIES

Profs. Friedrich Oltmanns and Adolf Pascher

SOME tribute should be paid to Profs. F. Oltmanns and A. Pascher, both of whom died in 1945 after making substantial contributions to the advancement of algal studies during the present century.

The name of Oltmanns, who for many years occupied the chair of botany in Freiburg in Baden, will be remembered as that of the author of the first comprehensive account of the Algæ. His "Morphologie und Biologie der Algen", published in 1904, constituted a landmark in the study of the Algæ and, by making available an authoritative account of the group, stimulated and had a far-reaching effect upon algal investigation in many different directions. The more extensive second edition, which appeared in 1922–23, was less inspired, and its utility was marred by the inadequate and frequently erroneous literature citations. The extensive treatment accorded to algal biology in the third volume failed to give a clear insight into the many outstanding problems.

Oltmanns, however, has other claims for inclusion among the outstanding algal workers of his period. He was the first to elucidate clearly the role of the auxiliary cells in Florideæ, and we owe to him considerable contributions to the knowledge of the Fucales and of the conditions of life of seaweeds. A special volume of the *Zeitschrift für Botanik*, which he edited for many years, was published in 1930 when he reached the age of seventy years.

Pascher, who was born in 1881, spent the whole of his academic life at the German University of Prague, where, during the latter part of his life, he occupied the chair of botany. His influence on algology was of a different and more profound nature than that of Oltmanns. One of his earliest researches, published in *Bibliotheca Botanica* in 1907, was concerned with the morphology and behaviour of the swarmers of diverse filamentous Chlorophyceæ. It was probably these studies that aroused his interest in flagellate organisms, to the knowledge of which he was to make so great a contribution. His investigation of the rich flagellate and algal flora of the Central European uplands extended over a period of more than thirty years, and resulted in the description of innumerable genera and species new to science.

An early outcome of these studies was the recognition of the fact that flagellate groups like the Chrysomonadineæ and Dinoflagellata (Peridinieæ) include also coccoid and filamentous types, comparable to those already known among the Chlorophyceæ and Xanthophyceæ (Heterokontæ), though Klebs in 1912 had already to some extent advanced this point of view for the Peridinieæ. In the brief memoir entitled "Ueber Flagellaten und Algen", published by Pascher in 1914, however, the Flagellata as a whole were placed in their correct relation to the Algæ, and the theory of the flagellate origin of Green and Yellow-green Algæ, first propounded in 1901 by Bohlin, was extended to the new classes Chrysophyceæ and Dinophyceæ. Emphasis was also laid on the remarkable degree of parallelism evident between the various algal series emanating from flagellate sources. These diverse theses were more fully elaborated in a series of papers published during the next twenty years, dealing with Chrysophyceæ, Dinophyceæ, and Xanthophyceæ, in which fundamental knowledge of each class was appreciably extended.

The great debt which botanical science owes to Pascher is the elucidation of the diverse lines along which algal evolution from flagellate stocks has taken place and of the definite pattern followed in this evolution. His numerous papers, however, include many other important contributions to the knowledge of Protista. Outstanding among these are the extensive studies of amœboid and rhizopodial forms of Algæ, which first disclosed clearly the significance of amœboid organisation, the exposure of the manifold relations between pigmented and colourless flagellate organisms, and the recognition of the affinity between Diatoms, Chrysophyceæ and Xanthophyceæ.

Later generations will no doubt also acknowledge the debt owed to Pascher in respect of the publication of the "Süsswasserflora", which probably gave an even greater stimulus to freshwater algology than did Oltmanns' book. Pascher's own contribution to this series of volumes was very considerable, and includes some of the most valuable parts. It is much to be deplored that he did not survive to produce a second edition of the volumes dealing with the Flagellata, of which he had so unrivalled a knowledge. His last comprehensive publication was the volume on Heterokontæ in Rabenhorst's "Kryptogamenflora", which was completed in 1939.

Pascher's numerous papers are characterized by lucidity and by the excellence of the accompanying illustrations, although sometimes a little marred by hasty editing. Most of his work was published in the *Archiv für Protistenkunde* and the Beihefte of the *Botanisches Centralblatt*, of both of which he was editor for a long period of years. His was a lovable, though sometimes rather impetuous, personality.

F. E. Fritsch

Mr. H. Brearley

Mr. Harry Brearley, the inventor of stainless steel, died on July 14 at the age of seventy-seven. A native of Sheffield, and the eighth child of a family brought up in "Ramsden's Yard", of which he has given a vivid account in a delightful autobiography, "Knotted String", he had only an elementary school education and then worked as a cellar lad in a crucible steel works. He was fortunate in being taken from this to be a laboratory boy under a capable and kindly analyst, who persuaded him to attend evening classes. He married young, and quite early collaborated with Fred Ibbotson in a book on the analysis of steelworks materials. In 1914 he went to Riga, then a Russian town, as chemist in a steel works associated with Messrs. Firth of Sheffield, where he improved the technique of hardening armour-piercing shells, having also to act as managing director when the Russian Revolution came and many members of the staff left. On returning to Sheffield he took charge of the Brown–Firth Laboratory, installed jointly by two neighbouring firms. Difficulties in the making of armour plates led him to the further study of the thermal treatment of alloy steels.

His introduction of a steel containing chromium with low carbon was intended to provide a more durable lining for gun barrels, and it was the observation that specimens in the laboratory, under certain conditions of heat treatment, were highly resistant to corrosion that suggested their use for cutlery. A Sheffield firm, R. F. Mosley, produced knives made of this steel which were not stained by fruit acids or similar solutions. Difficulties arose over the ownership of the invention, and in 1915 Brearley left the firm and joined Messrs. Brown Bayley, also of Sheffield. For a time, the patents were controlled by a special organisation, the Firth–Brearley Syndicate. Patent litigation involved a visit to the United States. Brearley retired in 1925 to Torquay. He and his brother devised the method of studying ingot structure by casting and sectioning wax models. He was awarded the Bessemer Gold Medal of the Iron and Steel Institute in 1920.

Without a university training, Brearley had a remarkable command of lucid English, and his books are models of their kind. A man of sturdy independence, a lover of good literature, and a metallurgist who rendered great services to the steel industry and to the men employed in it, he has a strong claim to be remembered among pioneers in industry.

C. H. Desch

We regret to announce the following deaths:

Dr. William Cullen, well known for his work in mining engineering and explosives, on August 14, aged eighty-one.

Prof. Beatrice Edgell, emeritus professor of psychology, Bedford College, London, on August 10, aged seventy-six.

Dr. Alexander Smith, assistant mycologist at the Ministry of Agriculture and Fisheries Plant Pathology Laboratory, Harpenden, on July 23, aged fifty-four.

NEWS and VIEWS

Chair of Entomology, University of Illinois:

Prof. G. Fraenkel

Dr. G. Fraenkel, lecturer in physiology in the Department of Zoology and Applied Entomology at the Imperial College of Science and Technology, London, has been appointed professor of entomology in the University of Illinois, Urbana, Ill., to take charge of the newly founded sub-section of insect physiology. Dr. Fraenkel, who was educated at the University of Munich, was an assistant in the Department of Zoology in the Hebrew University, Jerusalem, during 1928–30. During 1931–33, he was *Privatdozent* in zoology in the University of Frankfurt. From 1933 onwards, he has carried out research in insect physiology and the orientation of invertebrates at University College, London, and the Imperial College. Dr. Fraenkel has held his post as lecturer in physiology in the Imperial College since 1938. Most of Dr. Fraenkel's researches have been confined to insect physiology, including reflexes, pupation hormone of flies, function of halteres of flies, properties of cuticle and respiration. Since 1940 he has made a comprehensive study of insect nutrition supported by the Royal Society and, later, by the Medical Research Council. During the spring and early summer of 1947 he was guest professor in the University of Minnesota, where he gave a course of lectures on insect nutrition.

The National Radium Trust and Commission

With the coming into force of the National Health Act on July 5, the affairs of the National Radium Trust and the Radium Commission are being wound up. The two bodies were established by Royal Charter issued under Letters Patent of July 25, 1929. The functions of the Trust were primarily to augment the supply of radium (and later, by supplemental Charter, other radiotherapeutic apparatus) for use "in relation to the treatment of the sick in Great Britain" and "the advancement of knowledge of the best methods of rendering such treatment". The main duty of the Commission was "to make arrangements for the proper custody, equitable distribution, and full use of the radium . . . of the Trust with the object of promoting the treatment of the sick . . . and to make such arrangements for the supply on loan of the radium . . . as are necessary". When the Commission started work it was generally admitted that radium treatment in Great Britain had not attained the standard then reached by such centres as the Fondation Curie and the Radiumhemmet. During the last nineteen years, however, some of the national (university) radium centres set up by the Commission have achieved a reputation equal to the best anywhere in the world. At the same time, the standard of radiotherapy in general has been raised by the policy of centralization pursued by the Commission. Hospitals with small radiotherapy departments have been advised to make agreements with a national centre for the treatment of their patients, and the formation of small independent centres has been consistently discouraged. The present health organisation requires that the work hitherto done by the Trust and the Commission shall in future be undertaken partly by a Ministry of Health committee, and partly by the regional hospital boards. It is deemed advisable, therefore, that the radium and other radioactive substances, apparatus, appliances, funds and property belonging to the Trust and the Commission shall be dealt with by vesting them in the Minister of Health, or the Secretary of State for Scotland, as may be appropriate. The Royal Charter and the three Supplemental Charters are to be surrendered.

Market Research

The report of the Conference arranged by the Manchester Joint Research Council in Manchester on October 22, 1947, on "Market Research", has now been published (Manchester Joint Research Council. Market Research: Report of the Conference held on Wednesday, October 22, 1947, at the Albert Hall, Manchester. Pp. 108. (Manchester: Manchester Joint Research Council, 1948.) 2*s.* 6*d.*). It includes the full text of the three papers "The Technique and Applications of Market Research", "The Investigation of Trends of Consumer Tastes" and "Market Research and the Seller" submitted by Mr. O. W. Roskill, Mr. L. R. England and Mr. D. S. F. Vernon, respectively, together with their statements in presenting these papers and reports of the discussions. Summing up the discussions and the papers Mr. C. C. Renold said that, according to this composite picture, the broad purpose of market research was to provide answers to the questions, what does the customer, in fact, want, and, what is he likely to want in the future? These two questions immediately led to four others: who is the customer, what does he, in fact, buy, what is it that determines or influences his choice, and how much does he buy? The answers to some of these questions can be sought by statistical means; but, especially with consumer goods, other questions lead us into problems of psychology. The answers, too, have to be in two tenses—present and future—and they are determined not only by general movements of economics, trade or social habits, but also by the position of the manufacturer in relation to his competitors. The essential in market research was to select the subject most worth close examination by the techniques available. Mr. A. H. S. Hinchliffe, pointing out that the Manchester Joint Research Council did not itself undertake market research, referred to its information bureau as of possible service to firms unaware of sources of information or market statistics and as possibly able to advise firms on the best sources and consultants for carrying out particular pieces of market research.

Recently Introduced Fungicides

Lime-sulphur and Bordeaux mixture, both discovered in the last century, are still very effective and relatively cheap sprays for the control of fungus diseases. It is natural, however, to investigate the possibilities of other substances which might be either more effective or more economical. R. W. Marsh has carried out an extensive series of fruit-spraying trials with various new fungicides (*J. Pom. and Hort. Sci.*, **23**, 3 and 4, Dec. 1947). Phenyl mercury chloride was approximately equal to standard lime sulphur for the control of apple scab; in Grade E oil emulsion, it also gave promising inhibition of sporing of *Monilia fructigena*. Ferric dimethyldithiocarbamate and tetramethylthiuram disulphide are not phytotoxic, but are inferior as fungicides to lime sulphur. Heptadecylglyoxalidine equalled lime sulphur for apple scab control, and did not damage sulphur-sensitive varieties. The last substance, with dichlornaphthoquinone and dithiocarbamate sprays, gave satisfactory control of *Pseudopeziza* leaf-spot of black currants. Spread of brown rot infection of apples was reduced by ferric dimethyldithiocarbamate; but hydroxyquinoline sulphate showed no fungicidal value for apple scab.

Diseases of Mushroom Cultivation

The Mushroom Growers' Association is a body formed by a particular section of the horticultural industry in order to solve its own pressing problems. Some interesting features relating to mushroom diseases have recently appeared in the Association's Bulletin (Nos. 11 and 12, April and July, 1948). 'Cobweb', caused by overgrowth of beds by *Dactylium* species, is briefly described by Fred C. Atkins. The control of 'bubble', caused by the fungus *Mycogone perniciosa*, is outlined by Edmund B. Lambert. He regards as necessary a complete programme: burning sulphur and fumigating with formalin before the mushroom houses are used, taking water direct from uncontaminated deep wells, attaining a temperature of 120° F. for 48 hr. in the final fermentation of manure and casing soil, and general methods of hygiene. A new leaflet of the Association (No. 3) describes the general characters of *Mycogone* disease. A detailed account of the invasion of mushroom beds by truffles is contributed by A. M. Kligman, and, as control of most mushroom diseases involves rigid methods of hygiene, the necessary measures are considered in detail by R. L. Edwards and C. J. la Touche.

Cosmic Phenomena of the Past

In a paper, "Further References to Cosmic Phenomena in the Kitāb Al-Muntazam of Ibn Al-Jauzī, and a Few in Tārīk̲h̲-E-Rāḥat Afzā (India)", a reprint from *Islamic Culture*, April, 1948, Mohd. Abdur Rahman Khan provides a short account of thirteen fireballs from A.D. 983 to A.D. 1031; three comets from A.D. 974 to A.D. 1056; a comet in A.D. 1741, a detonating fireball in A.D. 1742, and another one in A.D. 1757 and an earthquake at the same time (it is conjectured that the earthquake may have been due to the impact of a large meteorite with the ground), and a slight earthquake in A.D. 1759. This information is additional to that published by the same author in his brochure "Meteoric Showers, Past and Present", some of which was discussed by him in the *Islamic Culture Magazine*, **20**, 4 (1946).

Scottish Conference on Road Research

An all-day conference to discuss road research problems will be held in Glasgow at the Royal Technical College on September 24. The conference is being called, with the collaboration of the Ministry of Transport, by Dr. W. H. Glanville, director of road research of the Department of Scientific and Industrial Research, in association with the Glasgow and District Association of the Institution of Civil Engineers, the Scottish branches of the Institution of Municipal Engineers and the County Surveyors' Society, and the Scottish Accident Prevention Council. The chairman of the conference will be Sir Patrick Dollan. The purpose of the conference is to bring the work of the Road Research Organisation before Scottish engineers and others concerned with roads and road traffic, and to provide an opportunity for discussing which research problems are of particular interest to Scotland. In addition to short papers by the director of road research and senior members of his staff, followed by an open discussion, there will be an exhibition of some aspects of the work of the Organisation. The morning session (deputy chairman: Colonel T. U. Wilson) will be devoted to materials and methods of construction, and the afternoon session (deputy chairman: Mr. G. J. Sherriff) to road safety and traffic flow. Owing to limitations of space, admission will be by ticket, obtainable from the Director of Road Research, Road Research Laboratory, Harmondsworth, West Drayton, Middlesex.

University of London: Appointments

The following appointments in the University of London have recently been announced: Dr. T. Crawford, University professor of pathology in St. George's Hospital Medical School as from October 1. Since 1946 he has been director of pathological services at St. George's Hospital and Medical School; Mr. D. V. Davies, University professor of anatomy in St. Thomas's Hospital Medical School as from October 1. Since 1944 he has been fellow and College lecturer at St. John's College, Cambridge, and in 1945 was Arris and Gale Lecturer at the Royal College of Surgeons; Mr. A. V. Judges, University professor of history of education in King's College as from January 1, 1949. Since 1938 he has held the title of reader in economic history in the London School of Economics and Political Science; Dr. R. T. Williams, University professor of biochemistry in St. Mary's Hospital Medical School as from October 1. Since 1942 he has been senior lecturer in biochemistry and during 1943–44 was in charge of the Department of Biochemistry at the University of Birmingham; Dr. G. L. Clark, University reader in mathematics in Bedford College as from October 1. Since 1947 he has been senior lecturer in mathematics at University College, Cardiff; Mr. T. A. Rodger, University reader in psychology in Birkbeck College as from October 1. He is at present senior psychologist to the Admiralty, consulting psychologist to the Central Juvenile Employment Executive and a lecturer in Birkbeck College.

Announcements

Mr. Derek Allan Hough has been appointed general secretary of the Institute of Petroleum with effect from September 1. Mr. George Sell has been appointed as editor of the Institute's publications with effect from August 1. Mr. Sell has been publications secretary since March, 1946.

Prof. Walter H. Bucher, of Columbia University, has been elected president of the American Geophysical Union to fill the unexpired term of the late Oscar E. Meinzer. This term will expire on June 30, 1950.

Mr. F. A. Secrett has resigned his position as honorary adviser to the Ministry of Agriculture and Fisheries on vegetable production, with effect from August 1. Mr. Secrett, who is himself a leading vegetable grower, has held this appointment since August, 1942. He will continue his membership of the Agricultural Improvement Council.

In recognition of his studies on "Sludged Blood" the College of Physicians of Philadelphia has awarded the Alvarenga Prize for this year to Dr. Melvin H. Knisely, of the University of Chicago. The Alvarenga Prize was established by the will of Pedro Francisco da Costa Alvarenga, of Lisbon, Portugal, an associate fellow of the College, "to be awarded annually by the College of Physicians on each anniversary of the death of the testator, July 14, 1883".

The Electronics Division of the U.S. Electrochemical Society is making preparations for a symposium on luminescence, to be held during its meeting in Philadelphia, from May 5 until 7, 1949. Further information can be obtained from Dr. R. M. Burns, Electrochemical Society, 235 West 102 Street, New York 25, New York.

The Nuffield Foundation has provided funds for the establishment of a research fellowship in extraction metallurgy, which will be awarded in consultation with the Institution of Mining and Metallurgy and the Royal School of Mines, London, and will be tenable at the Royal School of Mines for a period of five years. The funds are sufficient to provide a small specialist staff and the necessary equipment in addition to adequate remuneration for the fellow. Further information can be obtained from the Secretary, the Institution of Mining and Metallurgy, Salisbury House, London, E.C.2.

The Medical Research Council announces that it has awarded Rockefeller travelling fellowships in medicine to the following, for the academic year 1948–49: Dr. K. W. Donald, Medical Professorial Unit, St. Bartholomew's Hospital, London; Dr. L. P. R. Fourman, Nuffield Department of Clinical Medicine, University of Oxford; Dr. R. H. Girdwood, Department of Medicine, University of Edinburgh; Dr. A. Isaacs, Department of Medicine, University of Sheffield; Mr. A. I. S. Macpherson, Department of Surgery, University of Edinburgh; Dr. H. B. Stoner, Department of Pathology, University of Sheffield; Mr. S. F. Taylor, Department of Surgery, Postgraduate Medical School, London.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Origin of Some Plant Viruses

POTATO paracrinkle virus, discovered by Salaman and Le Pelley[1], has been found in every plant of the variety King Edward that has been examined, but never in other varieties in the field, although it can be transmitted to them by grafting. The inference is that it has no natural means of spreading, and must have been present in the original seedling from which the variety King Edward came.

It is reasonable to infer that the virus was in the seedling because it was a seedling, and either is part and parcel of the clonal variety, or arose during some phase in the life of the seedling not shared by plants propagated vegetatively. The first alternative is ruled out because the virus is not transmitted by seed and behaves in general like other viruses, as Carson *et al.*[2] pointed out in reply to Darlington's suggestion[3] that the virus was a protein constituent of the variety. This leaves the second, which means that the virus arose in the germinating seed or very young seedling, because these are the only phases in the life of a seedling that are not shared by plants propagated vegetatively.

There is evidence for the belief that potato paracrinkle virus is not unique in its origin, and that other plant viruses may have arisen in germinating seed. The biochemical processes during germination are to some extent the reverse of those during the formation of the seed—food reserves built up in the seed are broken down during germination—and if viruses arose during germination there would be a fair chance that they would be destroyed in the seed as it forms. This is precisely what happens, for destruction of those viruses that manage to enter the seed seems universal, even if it is sometimes incomplete. The suggestion that viruses have arisen from occasional syntheses during germination is the simplest explanation of this destruction.

It might be argued that the prevalence of viruses in plants propagated vegetatively is against the suggestion; but this is not so, because one can usually trace a connexion with propagation by seed. Consider the largest two groups of plant viruses: those of stone fruits and of potatoes. Stone fruits are usually (but not invariably) budded on seedling stocks; and, granted a susceptibility of *Prunus* towards viruses, there is (on the present suggestion) the ideal combination for the establishment of new viruses: seedling stocks to produce them and vegetative propagation of varieties to give them a less poor chance of survival. Potatoes are nowadays raised from seed only for the production of new varieties (with the consequence in King Edward already noted). But the raising of new stocks from seed was once common in Europe as well as in the original home of the potato; and it may be significant that, whereas several of the viruses of stone fruits discovered in recent years were not only previously unrecorded but, on local evidence, apparently new, there is no evidence that outside South America the potato viruses, with the exception of paracrinkle virus, are modern.

On following the line of thought in the second half of the previous sentence, it was found that the number of virus diseases first recorded in the literature after the publication of K. M. Smith's "Textbook" in 1937, relative to the number recorded before, is significantly greater for plants usually grown from seed or on seedling stocks than for plants usually propagated only by vegetative means. Details of the test of independence are given in Table 1, which is based on the 156 viruses contained in Wiltshire's[4] list published in 1946, the classification being made on the host plants which give the viruses their common names, and on the dates when the diseases were first recorded, irrespective of whether they were then ascribed to viruses or not. An identical trend is also shown in Table 2, which, to remove any bias that vegetative propagation may give to the detection of virus diseases, is confined to vegetatively propagated plants, and compares plants like peaches, which are usually on seedling stocks, with plants like potatoes, which are usually propagated by simple vegetative means, or, like roses, on stocks raised vegetatively. The records of plant virus diseases are still fragmentary and perhaps unrepresentative, and the host plants after which the viruses are named are sometimes clearly not the original hosts, but the difference between the two sets of records as they now stand is unquestionable. Closer analysis of the effect of time revealed no evidence that the choice of date, 1937, had much to do with this difference.

Table 1. Number of first records of plant virus diseases. Figures in parenthesis are for woody and herbaceous plants respectively

	Plants grown from seed or on seedling stocks	Plants propagated vegetatively	Total
Before 1937	68 (19, 49)	52 (18, 34)	120 (37, 83)
1937 and after	31 (13, 18)	5 (3, 2)	36 (16, 20)
Total	99 (32, 67)	57 (21, 36)	156 (53, 103)

χ^2 for all plants = 10·35; for woody plants = 4·17: for herbaceous plants = 6·80. The 1 per cent and 5 per cent points are 6·64 and 3·84 respectively.

Table 2. Number of first records of virus diseases of plants which are usually propagated vegetatively

	Usually on seedling stocks	Usually vegetative propagation only	Total
Before 1937	12	52	64
1937 and after	11	5	16
Total	23	57	80

χ^2 = 15·62; 1 per cent point = 6·64.

It is not supposed that all diseases recorded since the beginning of 1937 are new, even if, to allow for the inevitable lag in time between the synthesis of a virus and the discovery and record of the disease it causes, one interprets the adjective as covering the last few decades. But it is possible that enough viruses are new enough to influence the date of discovery of the diseases they cause, and thus, if they arise in the seed, to give the records the trend they have. Fortunately, the analysis is one which will automatically improve as records become less fragmentary, and time will allow one to give the possibility a better test.

To conclude, it is suggested that the synthesis in healthy tissue of enough virus to effect further multiplication is a rare event which happens in the protein-rich seed during the intense chemical activity of germination. Rarity is a clear demand of the statistical argument, one successful synthesis followed by successful dispersal being all that is really needed for each virus; and this demand allows a theory of heterogenesis to conform with the substance of the teachings of Pasteur.

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March 2.

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[1] Salaman and Le Pelley, *Proc. Roy. Soc.*, B, **106**, 140 (1930).

[2] Carson, Howard, Markham and Smith, *Nature*, **154**, 334 (1944).

[3] Darlington, *Nature*, **154**, 164 (1944).

[4] Wiltshire, *Rev. Appl. Mycology*, **24**, 515 (1946).

Rh Genes Allelomorphic to *D*

STRATTON[1], in 1946, described an *Rh* gene allelomorphic to *D* and *d*, to which he gave the name D^u. He demonstrated that this allelomorph was inherited in the same way as the other *Rh* genes. During the last two years we have had the opportunity of testing twenty-eight samples of blood of the genotype D^ud, nineteen of which were from unrelated English persons.

The tests were exhaustive; they included titrations in saline and in albumin against numerous anti-*D* sera, and tests by the anti-globulin and by the elution techniques. We consider a sample of blood to be D^ud if it gives some of, but not all, the reactions expected of *D* when tested by these various methods against the battery of agglutinating and incomplete anti-*D* sera. The homozygote D^uD^u must be very rare in England, and in the heterozygote D^uD the presence of D^u is masked by that of *D*.

Red cells		12 anti-*D* Sera											
Da.	CD^ue/cde	–	–	–	–	+	+	–		–	–	–	–
Sh.	,,	–	–	–	–	+	+			–	–	–	–
Am.	,,	–	–	+	+	+	+	+	+	+	+	–	–
Br.	,,	–	–	+	+		+	+		+	+	+	–
Ma.	cD^ue/cde	–	–	+	+	+	+	+		+	+	+	+
Bl.	CD^ue/cde	–	+	+	+		+	+		+	+	+	+
CDe/cde control		+	+	+	+	+	+	+	+	+	+	+	+
Lo.	CD^ue/Cde	–	+	+	+		+	+		+	+	–	–
Mar.	cD^uE/cde	–	+	+	+		+	+	+	+	+	–	–
Ab.	,,	–	+		+		+	+	+	+	+	–	–
Gr.	CD^ue/cde	–	+	–	+		+			+	–	–	–
Cu.	CD^ue/Cde	–	–	–	+		+	+		+	–	–	–
Th.	CD^ue/cde	–	–	–	+	+	+	+		+	–	–	–
Gi.	CD^ue/Cde	–	–	–	+	+	+	+	+	+	–	–	–
Se.	cD^uE/cde	–	–		+		+	+		–	–	–	–
Le.	CD^ue/cde	–	–	–	+		+	+	+	–	–	–	–
Jo.	,,	–	–	–	–	+	+	+		–	–	–	–
Po.	CD^ue/Cde	–			–	–	+						–
Ho.	CD^ue/cde	–	–	–	+		–	–	–	–	–	–	–
Pi.	,,	–	–	–	+		–	–	–	–	–	–	–

The reactions of the blood of the nineteen unrelated English persons with twelve anti-*D* sera are shown in the accompanying table. The twelve sera had each disclosed slight variations in the specificities of their anti-*D* when they were tested against the nineteen samples of blood. About thirty antisera were used; but the rest appeared to give the same reactions as one or other of the twelve. Conversely, the antisera defined twelve different types of D^ud blood, and presumably if the battery of antisera had been larger, more of the nineteen samples of D^u blood would have been distinguishable.

Examination of the families of ten of the nineteen persons confirmed Stratton's views of the inheritance of D^u; but it went further, and left very little doubt that the fine distinctions between the different types of D^u are also genetically determined, for with one exception the blood of related persons gave identical D^u reactions.

The apparently unlimited number of D^u allelomorphs, together with the very arbitrary way in which the antisera were reacting with them, recalled the work of Dubinin on the many allelomorphs at the scute locus in *Drosophila melanogaster* (as described by Waddington[2]). The problems seemed to have sufficient in common to stimulate us to seek, by rearranging our results, for some such pattern as that into which the scute results apparently fitted. This could be done by cutting up the original most bewildering table first vertically for the sera; then, having decided on their order, redrawing the table and cutting it horizontally for the ordering of the cells. The result was the striking pattern shown in the table. It will be seen that two samples of blood do not fit in at all, but that the remaining seventeen show a horizontal and vertical contiguity of positive reactions uninterrupted by intervening negative ones. There is only one exception to this, in the horizontal direction, about halfway down the table.

It is difficult to decide whether the pattern is a chance one. If it is significant, then the horizontal conjunction of positive signs seems to impose a linear order on the different forms of D^u. It suggests that if the differences between the D^u's are due to mutations, then the mutations may be additive in nature. The vertical conjunction of positive reactions would suggest that an anti-*D* antibody is built up according to a progressively expanding plan.

It should be mentioned that D^u is much too rare to have been the antigen responsible for the immunization of the twelve mothers whose sera are shown in the table. Probably all these anti-*D* sera were made in response to the antigen *D*. It should also be made clear that all twelve antisera would agree in giving positive or negative reactions with at least 99 per cent of blood samples. It is only over the rare D^u bloods that they disagree. The range of an anti-*D* serum in agglutinating D^u cells is not wholly dependent on the titre of the serum, though there is a positive relationship between range and titre.

The different D^u samples can be graded from those that are agglutinated in saline by most anti-*D* sera down to those which can only be recognized as having any D^u component by giving a positive anti-globulin test with incomplete anti-*D* serum. Blood of the latter type will usually have been classified as Cde/cde or cdE/cde.

The *C* or *c*, *E* or *e* genes with which D^u is usually combined in England strongly suggest that the mutation to D^u, if it is a mutation, occurs to a *D* gene rather than to a *d* gene.

The type of blood called $R'r$ (and the same applies to $R''r$) consists of two groups probably differing fundamentally in origin. One group, perhaps the larger, is really antigenically low-grade D^u and is of the genotype CD^ue/cde, which we consider has arisen by mutation in a CDe chromosome. The other group contains the true Cde/cde, which, according to the suggestion of Fisher for which there is some striking support, has arisen as a cross-over between CDe and cde chromosomes.

A detailed account of the family and serological investigations will be reported elsewhere.

We are indebted to many *Rh* workers for sending us samples of D^u blood and anti-*D* sera. Particularly we would like to mention Dr. F. Stratton, Dr. F. S. Stewart, Mr. I. Dunsford and Dr. A. E. Mourant.

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[1] Stratton, F., *Nature*, **158**, 25 (1946).

[2] Waddington, C. H., "Introduction to Modern Genetics" (London, George Allen and Unwin, 1939).

In 1945 a cell sample was discovered reacting with only a proportion of anti-*D* sera. This suggested a new allele of *D* which was called D^u [1]. 209 *Rh* antisera stored at – 20° C. for periods up to several years have been tested with D^u cells of types CD^ue and cD^uE, selecting the appropriate cell to avoid the effect of anti-*C* and anti-*E* agglutination in sera containing more than one antibody. 102 of these sera contained anti-*Rh* agglutinins, and 37 of these (36 per cent) agglutinated D^u cells, some weakly, some very strongly. These sera all contained anti-$D + D^u$ agglutinins; anti-D^u by itself has not been detected. 71 of these agglutinating sera were free from anti-*C* and anti-*E* agglutinins, and 27 of these (38 per cent) agglutinated D^u cells. These 27 comprised 13 per cent of all the sera tested. The remaining 107 sera contained incomplete antibodies, many of which were weak; and 36 of them (34 per cent) gave positive Coombs tests with D^u cells. Eight of these gave positive albumin tests also, and five sera gave positive albumin tests only. In addition, strong incomplete *Rh* antibodies from ten cases of incompatible transfusion all gave positive Coombs tests with D^u cells, as did ten agglutinating sera which gave negative agglutination with D^u cells.

D^u cells vary in the strength of their reactions and in the number of agglutinating sera with which they react; and some are negative with all agglutinating sera, so that R_1 (CD^ue) and R_2 (cD^uE) may only be distinguishable from R' (*Cde*) and R'' (*cdE*) by the positive Coombs tests which they give with certain incomplete anti-*D* sera, especially those from cases of incompatible transfusion. A series of strongly positive albumin tests, on the other hand, suggests that the cell is an ordinary *Rh* positive one and does not contain D^u, since D^u only rarely gives positive albumin tests with incomplete anti-*D* sera.

The best method of investigation has proved to be the comparison of the reactions of various cells with a large number of sera, and we have examined fifty cell samples mostly thought to be R' (*Cde*) and R'' (*cdE*) in the first instance. They were tested with forty-nine agglutinating sera, and with fourteen incomplete anti-*D* sera, employing the Coombs test and albumin test. Detailed results will be published elsewhere; but a selection is given in the accompanying table. D^u cells vary in strength from very weak reactors to those which are scarcely distinguishable from ordinary *D* positive cells.

It will be observed that the D^u antigen in cell No. 39 can only be detected by the Coombs test. This cell gave negative albumin tests even with three specially selected incomplete anti-*D* sera which gave strong albumin tests with more strongly reacting D^u cells, such as cell No. 13.

Several samples of maternal blood of group R' (*Cde*) or R'' (*cdE*) containing *Rh* antibodies were examined; but no evidence of the presence of D^u was found. For this reason, and since van Loghem[3] found that D^u could be antigenic to an *Rh* negative person, D^u is considered to be *Rh* positive and should be excluded when selecting *Rh* negative blood donors. The most practical way to do this as a routine is by the use of anti-*C* and anti-*E* sera in addition to the use of several anti-*D* sera. This will exclude the vast majority of D^u positive cells. D^u also has a practical importance in that R_1 (CD^ue) and R_2 (cD^uE) cells are readily mistaken for R' (*Cde*) and R'' (*cdE*); and if such cells are used for testing purposes, one may falsely be led to suppose that agglutinating or blocking sera contain anti-*C* or anti-*E* antibodies in addition to anti-*D*.

Inheritance of D^u has been demonstrated, but we are at present making more family studies to substantiate the hypothesis that D^u is a term covering a series of alleles or modifications of the *D* antigen at the *D*—*d* locus.

Since sera which agglutinate D^u cells do so to a lower titre than the same sera agglutinate cells containing the ordinary *D* antigen, and since absorption of sera with either *D* or D^u cells does not effect any separation of the antibodies anti-*D* and anti-D^u, it might be thought that the phenomena were quantitative and dependent on a varying amount of the *D* antigen in the cell. However, this cannot be the case since the sera which agglutinate the greatest number of D^u cells are not always those with the highest titres when tested against cells containing the *D* antigen, and since cases have been found where, of a pair of sera, only one agglutinated one sample of D^u blood while the other agglutinated the second.

Type of serum	Agglutinins								Incomplete antibodies						
	Anti-*C*	Anti-*D*						Anti-*E*	Coombs test Anti-*D*			Albumin test Anti-*D*			
Serum No.	19	35	37	40	20	28	16	43	11	7	9	11	7	9	
Cell No.															Conclusion
1	–	64	64	4	16	16	4	++++	++++	++++	++++	+++	+++	+++	R_2 (*cDE*)
13	–	8	8	1	1	–	–	++++	++++	++++	+++	–	–	–	R_2 (cD^uE). Strong reactor
23	–	2	1	1	–	–	–	++++	++++	+	++++	–	–	–	R_2 (cD^uE). Medium reactor
15	++++	W	–	W	–	–	–	–	++++	–	++++	–	–	–	R_1 (CD^ue). Weak reactor
39	–	–	–	–	–	–	–	++++	+++	–	++	–	–	–	R_2 (cD^uE). Weak reactor
14	++++	–	–	–	–	–	–	–	–	–	–	–	–	–	R' (*Cde*)
8	–	–	–	–	–	–	–	++++	–	–	–	–	–	–	R'' (*cdE*)

Number of +'s indicates strength of reaction. W = weak. – = negative. Figures indicate the titre of strongly positive reactions.

Nevertheless, it was found that the sera with the highest titres for *D* cells were frequently good agglutinators of D^u, so that it does appear that a serum containing a strong anti-*D* agglutinin is more likely to react strongly with D^u.

When antigens like *D* and D^u are closely related, the possibility of a cross-reaction of each antigen with antibodies produced against the other is high. This shows that while a quantitative element is involved, there are also distinct qualitative differences between *D* and D^u.

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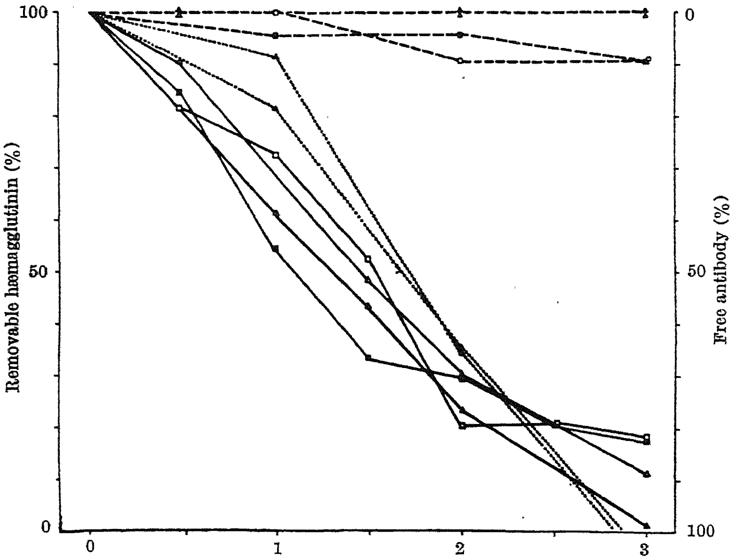
[1] Stratton, F., *Nature*, **158**, 25 (1946).

[2] van Loghem, *Brit. Med. J.*, ii, 958 (1947).

Viropexis, the Mechanism of Influenza Virus Infection

Cellular receptors capable of reacting with influenza viruses (such as those on erythrocytes, and the cells lining the respiratory tract of the mouse or the allantoic cavity of the chick embryo), when treated with appropriate amounts of periodate, still adsorb virus; but spontaneous elution does not occur nor can artificial liberation be induced by the 'receptor-destroying enzyme' of *V. choleræ*, an agent known to remove bound virus from normal receptors. On the basis of a detailed study, it was concluded that the substrate for the receptor-destroying enzymes of the virus or vibrio is altered by periodate ions without significant change in the adsorptive capacity of the receptor area, so that the contact of such treated cells with virus results in an irreversible receptor-virus combination[1]. In further experiments it was shown by four independent methods, both in mice and developing chick embryos, that despite 'modification' by periodate, infection takes place through such receptors; obviously, these conditions do not allow of any enzymatic action of the virus on the receptor substance[2]. The uptake of the particle adsorbed to the exoplasm of the future host cell is believed to be a process essentially similar to the phenomenon of colloidopexis.



Percentage of recoverable virus (active and heat-killed) in allantoic cavities lined with living or dead cells

—— Untreated eggs, living; .... periodate treated eggs, living; --- formolized eggs, dead.

□ active virus, ■ heat-killed virus } receptor-destroying enzyme liberation technique

△ active virus, ▲ heat-killed virus } antibody neutralization technique

Each point represents the average from 36 eggs

Since the objection may be made that this mechanism is at work only on receptors previously modified by periodate, further experiments using heat-killed virus and normal receptors were carried out.

The allantoic fluid of living eggs was removed, and replaced by physiological sodium chloride solution containing a standard amount of active or heat-killed (30 min. 56° C.) Lee virus. At intervals ranging from 0 to 180 minutes, a potent receptor-destroying enzyme preparation was inoculated to remove virus still present at the surface of the cells. The fluids were harvested at the end of the fourth hour, and titrated for their agglutinin content. The experiment was repeated with eggs the allantoic lining of which had been killed by formaldehyde. The percentage of removable virus at different intervals is given in the accompanying graph.

In a second series of experiments, use was made of the fact that specific antibody combines with virus only outside the cell. The second inoculum in this case contained antiserum sufficient to neutralize the amount of virus—active or heat-killed—given in the first inoculum, and the drop in anti-hæmagglutinin titre served as a measure of virus present at the surface of the cells or in the fluid. The experiments were performed on normal, formolized and periodate-treated eggs.

From the graph it is clearly seen that both active and heat-killed viruses disappear from allantoic cavities with living cellular lining, irrespective of whether the receptors are normal or modified by periodate. In formolized cavities, that is, cavities lined with dead cells, all the virus is recovered. Obviously, the penetration by the virus of the cell membrane does not depend on the viability or enzymic activity of the infective particle, but only on the functional integrity of the host cell.

The 'enzyme-substrate combination hypothesis', recently reiterated by Hirst[3] on no better evidence than originally proposed[4], cannot be accepted in the light of the above findings. All Hirst's experiments to elucidate the mechanism of infection were performed on non-living systems or on non-host cells, the strongest proof in favour of his assumptions being the momentary lack of contradictory evidence.

The above results, taken together with the fact of influenza infection through periodate-modified receptors, suggest a different mechanism. Specific adsorptive combination between the cellular 'receptor area' and the viral 'combining area' ('B-spots' in the terminology of Burnet[5]) is followed by the ingestion of the infective particle. This phenomenon strongly recalls the uptake by cells of colloidal dyes, and may therefore be termed 'viropexis'. Enzymic activity and destruction of receptors—formerly postulated as prerequisites for the penetration of the virus into the interior of the host cell—do not seem to be essential, though possibly the invariable occurrence in natural infections with enzyme-possessing viruses.

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[1] Fazekas de St. Groth, S., *Aust. J. Exp. Biol.* (in the press).

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[3] Hirst, G. K., *J. Exp. Med.*, 87, 301 (1948).

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Polyploidy in Bacteria?

In the course of experiments on the bactericidal action of X-rays on the *R* and *S* phases of *Escherichia coli*, it was found that the survival-rate in three stocks (76, 111, *Ida*), irradiated twenty-four hours after seeding, was different[1]; one of them (stock *Ida*) was more resistant to the radiation as compared with the other two stocks. No significant differences were found between *S* and *R* phases of the same strains. According to the hit-theory of biological effects of radiation the survival-rate is a measure of the target volume, which has been assumed to represent the bacterial 'nucleus'[2,3]. If in the case of bacteria the so-called nucleoplasmic ratio of plants and animals holds true, and if, on the other side, the target volume obtained from X-ray experiments really represents the size of the bacterial 'nucleus', one would expect the size of the bacterial cells to be correlated to the target volumes. A biometric analysis of twenty-four hours old bacteria, carried on the projected images of photomicrographs of bacteria stained with Henrici's Congo Red method[4], has shown that *E. coli* with a larger target volume are larger than the ones with smaller target volume. The variability curves obtained for the three stocks were almost normal, and the differences found between their means were statistically significant. It is suggested that such correlation might indicate the presence of polyploidy among different stocks of the same bacterial species, as it has previously been found in other organisms. A detailed description of such experiments will be published elsewhere.

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Occurrence of *Talorchestia brito* on the Coast of Northumberland

Talorchestia brito was originally described by Stebbing in 1891 from specimens collected on the north Devon coast[1]. No further records of its occurrence on the coasts of Britain can be found, though, according to Chevreux and Fage[2], it has been recorded from a number of scattered points on the Continent from the eastern English Channel to the western Mediterranean. It has now been found about three hundred miles north of any previous record near Blyth, Northumberland, being moderately common between high-water neap and high-water spring tides in the coarse sand to the south of the town. The species appears to be restricted to this stretch of about two miles, and has not been found on any other sandy beach in Northumberland or north Durham.

On July 6, 1948, the population of *T. brito* consisted of adults, including females carrying eggs, and recently hatched young. *Talitrus saltator* was also present, but was much less abundant.

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July 16.

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[2] Chevreux, E., and Fage, L., *Faune de France*, 9, Amphipodes (1925).

Laminaria ochroleuca De La Pylaie Growing on the Coast of Britain

On April 10, 1946, a *Laminaria* plant, trawled in Plymouth Sound and brought into the Plymouth Laboratory by Miss M. F. Sutton, Department of Biology, Chelsea Polytechnic, was identified by me as *Laminaria ochroleuca* De La Pylaie, a species of *Laminaria* that had not previously been recorded from the coasts of Britain. As trawling over the same ground on subsequent days failed to procure further plants of this species, the record was not published. A recent survey, however, has shown that this species occurs quite frequently in the more sheltered parts of Plymouth Sound. It is found on rocky ground from just below, down to eight metres below, low water spring tides, growing usually with *L. cloustoni* Edmondst. or *Saccorhiza bulbosa* De La Pylaie.

L. ochroleuca can be distinguished at any time of the year from *L. digitata* (L.) Lamour. and *L. cloustoni* Edmondst. by the colour of the base of the frond, which is always whitish-yellow, and by the smooth stipe which contains mucilage canals in the outer layers. During the spring and early summer, when frond growth is very rapid, the whole frond is a pale yellowish-brown; but during late summer, autumn and early winter, when growth is slower, the distal part of the frond becomes darker, the distinguishing whitish-yellow colour being noticeable only at the base.

L. ochroleuca (= *L. lejolisii* Sauvageau, *L. pallida* (Grev.) J. Ag. var. *iberica* Hamel, *L. iberica* (Hamel) Lami) is recorded from the western Mediterranean and from the north-eastern Atlantic. On the French side of the Channel it is recorded at localities from Finistère to Cotentin. There are also records of its occurrence in the Channel Islands.

Dr. Robert Lami, of the Muséum d'Histoire Naturelle, Paris, who has worked on the distribution of this species on the French coast[1], informed me in 1945 that he thought this species might have 'crossed the Channel' and invaded the south coasts of England and Ireland because of its abundance on the coast of Brittany. Plants up to five years old are now present in Plymouth Sound; but it is not known how long this species has been there. It was almost certainly not present up to 1900, otherwise it would have been recognized and recorded by Prof. T. Johnson[2], who made an intensive study of the marine algæ of Plymouth Sound during 1885–1900. I would, therefore, be grateful for any records of the occurrence of this species on the coasts of Britain, so that its distribution or its rate of migration can be followed.

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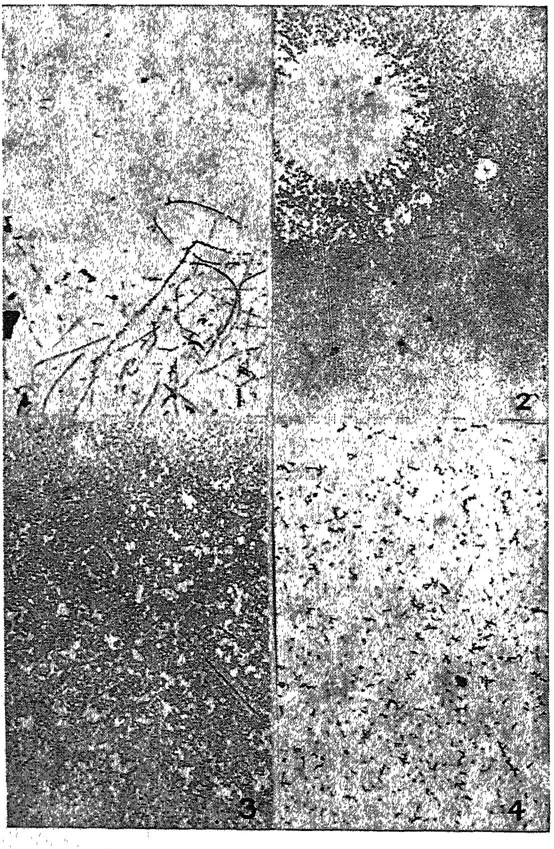
[2] Johnson, T., *J. Mar. Biol. Assoc.*, 1, 286 (1900).

Insecticidal Power and Microscopical Structure of Residual Films of Benzene Hexachloride

IN some recent experiments with samples of the γ-isomer of benzene hexachloride (1,2,3,4,5,6-hexachlorocyclohexane), in which adult beetles of *Dermestes maculatus* Deg. were tested on residual films prepared on glass plates by a recently devised method[1], it was found that in films formed from chloroform solutions, a certain sample of 'technical' grade material (I) was more insecticidal than the corresponding 'refined' sample (II) and 'refined' (III) and 'technical' (IV) samples of different manufacture. These unexpected observations were the reverse of those obtained by other investigators testing the same samples by different methods[2]. Furthermore, when residual films of the insecticides in a light, refined paraffin spray oil were prepared and tested in this laboratory, samples (II) and (III) were at least as toxic as (I).



A microscopical examination of the chloroform films showed that those prepared from sample (I) were different from the others. After a few hours films of (II), (III) and (IV) had crystallized (Figs. 2, 3 and 4), whereas those of (I), prepared at the same time, under the same conditions, had not: the film was present in the form of discrete globules (Fig. 1, upper). These globules crystallized after insects had walked on them (Fig. 1, lower). Unfortunately, because of the high volatility of benzene hexachloride and the resulting short life of the films, it has not so far been possible to obtain crystals in chloroform films of (I) in any other way. Examination of residual films resulting from light paraffin solutions, where crystallization was considerably retarded in every case, showed that films of samples (I) and (IV) were most retarded.

It is of interest to compare these observations with those of Parkin and Green[3], who found, however, that crystallization of globule films of D.D.T. resulted in increased toxicity.

At this juncture no full explanation of my observations can be offered. It seems reasonable to suggest, however, that the unexpectedly high toxicity of sample (I) is not entirely due to an impurity, but may be associated with traces of chloroform retained by the film. The matter is being further investigated.

Thanks are due to Dr. R. A. E. Galley for supplying nformation, and to the Council of this Research Association for permission to publish.

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Synthesis of *l*-Sparteine

IN view of the synthesis of *dl*-sparteine reported by Leonard and Beylen[1], we wish to place on record that some time ago we effected the reduction of *l*-oxysparteine to *l*-sparteine by treatment with lithium–aluminium hydride. Full details of this work will be published elsewhere in due course.

Since the total synthesis of *dl*-oxysparteine[2], the resolution of *dl*-lupanine[3], the transformation of this and its *d*-component into *dl*- and *l*-sparteine respectively[3,4] and the oxidation of *dl*-sparteine to *dl*-oxysparteine[4] have been accomplished in these laboratories, the structure of *l*-sparteine is now completely established.

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R. RAPER
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[1] *J. Amer. Chem. Soc.*, 70, 2298 (1948).

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Testicular Hypoplasia and Epididymal Cysts in the Syrian Hamster

We have observed certain definite changes in the testes of some inbred hamsters. These changes are characterized by a striking testicular hypoplasia, mostly bilateral. Such testes, represented sometimes by structures which are almost invisible to the naked eye, appeared very pale, with an apparent lack of normal vascularization. Their individual weight was only 2–306 mgm., as compared with a testicular weight of 0·900–1·400 gm. in the normal hamster. However, we have observed fertile animals the individual testes of which weighed only 0·580 gm. The hamsters with bilateral hypoplasia were, without exception, sterile. On the other hand, the animals with unilateral hypoplasia proved to be fertile. No relationship was found between the hypoplasia and the growth-rate or mature weight of the animals. Although we have also observed hypoplasia of the ovaries and sterility in some females, our data in this respect are inconclusive.

In the epididymi of some inbred and outbred hamsters we have encountered single and multiple cysts, histologically connected with the epididymis itself. Such cysts, of a yellow colour and of a sterile content, varied greatly in size: they varied from the size of a very small pearl to that of a normal hamster testis. In some animals these cysts were found in both epididymi, although most of them were unilateral. Most of the cysts were found in the tail, although a few of them occurred in the head of the epididymis. Most of them contained mainly spermatozoa.

Through the study of the reproductive capacity of hamsters with normal testes but with epididymal cysts, unilateral or bilateral, in some cases making use of surgical ligatures, we observed that the cysts impaired the fertility of the animals only when they were of considerable size, especially when such cysts were located near the beginning of the ductus deferens. This shows that these cysts can produce sterility only by mechanical blocking of the normal passage of the spermatozoa through the epididymis.

In a few cases we have also observed another kind of cyst, the contents of which are devoid of spermatozoa. They are small, yellow formations, usually flattened, round or ovoidal. These cysts are found either free, in the neighbourhood of, or loosely connected to, the tail of the epididymis.

The testicular hypoplasia was observed only in a group of inbred hamsters. They were of different age, 92–240 days, and under different dietary regimes. The epididymal cysts, found in both inbred and outbred animals, were observed mostly in very mature hamsters, 220–240 days of age. The cause of the hypoplasia seems to be of a hereditary nature, similar to that described by Lagerlöf[1,2] and Eriksson[3] in cattle. A complete report with a histological study is being prepared.

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[1] Lagerlöf, N., *Vet. Rec.*, 48, 1159 (1936).

[2] Lagerlöf, N., Proc. 13th International Veterinary Congress, Zurich, 1, 214 (1938).

[3] Eriksson, K., "Hereditary Forms of Sterility in Cattle", 1 (Håkan Ohlssons Boktryckeri, Lund, 1943).

Isophosphorylase

Both pure potato phosphorylase[1] and crystalline muscle phosphorylase[2] produce from glucose-1-phosphate a non-branched polysaccharide containing only α-1,4-glucosidic links and resembling amylose. By the action of extracts of yeast[3], of heart, brain or liver[4], branched polysaccharides are obtained containing up to 10 per cent of α-1,6-glucosidic linkages and resembling glycogen. In 1942, Meyer and Bernfeld[5] reported the presence of an enzyme in yeast which brings about the phosphorolysis of the terminal α-1,6-glucosidic links of residual dextrin (the final degradation product of amylopectin by β-amylase). A purified potato phosphorylase was not able to effect this reaction. It was therefore concluded[5] that there are two different phosphorylases, one of which effects the fission or synthesis of α-1,4-glucosidic links, the other the α-1,6-glucosidic links involved in branching. Cori[6] has found an enzyme in liver extract and also in heart extract which he calls the 'branching factor', and which is able to produce glycogen by simultaneous action with the crystalline muscle phosphorylase. Haworth, Peat and Bourne[7] have described a thermolabile factor which they term the '*Q* enzyme' and to which they attribute the property of synthesizing the α-1,6-glucosidic links in amylopectin. Their '*Q* enzyme' has, in addition, an amylatic action.

We have now succeeded in finding also in potato extract an enzyme which, in the presence of inorganic phosphate, renders residual dextrin accessible to β-amylase attack (see Table 1).

Table 1. Simultaneous action of potato extract and β-amylase on residual dextrin

Addition of potato extract	Degradation by β-amylase	
	Phosphate present	Phosphate absent
Without	0 per cent	0 per cent
With	25 „	5 „

We have been able to show that, in the presence of phosphate, this same enzyme converts amylose to amylopectin and even to glycogen by simultaneous action with potato phosphorylase (see Table 2). No conversion takes place in the absence of inorganic phosphate.

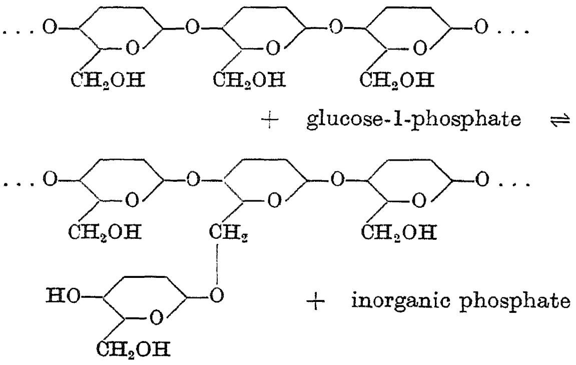
Table 2. Simultaneous action of potato extract and potato phosphorylase on corn amylose

Time in hours	Phosphate present 1·35 P/amylose*		Phosphate absent less than 0·01 P/amylose*	
	Iodine coloration	Conversion limit by β-amylase[8]	Iodine coloration	Conversion limit by β-amylase[8]
0	blue		blue	
24	violet		blue	
72	purple		blue	
144	purple	65%	blue	100%

* Mols of phosphate per glucose equivalent of amylose.

The results given in Tables 1 and 2 show that potato extract contains an enzyme capable of catalysing the phosphorolysis of α-1,6-glucosidic links and equally of their synthesis. We propose to call this enzyme 'isophosphorylase'.

Meyer and Bernfeld[5] have shown that potato phosphorylase only brings about the fission of α-1,4-glucosidic links which are proximate to terminal non-reducing groups. This has been confirmed quite recently by Katz, Hassid and Doudoroff[9]. We have found that isophosphorylase does not attack linkages in the interior of the molecule, and in this respect behaves like phosphorylase, as the viscosity of a starch paste is not reduced in the presence of isophosphorylase. The reversible catalytic effect of isophosphorylase may therefore be schematically represented as follows :



Furthermore, the behaviour of isophosphorylase with regard to the viscosity of starch paste proves the absence of any α-amylatic action in our preparations, which are thus distinct from the '*Q* enzyme' of Peat, Bourne and Barker[7].

We are indebted to Prof. K. H. Meyer for his interest in this investigation.

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Astaxanthin in Insects and Other Terrestrial Arthropods

IN a very interesting note on the carotenoids of the locust integument, Goodwin and Srisukh[1] point out the presence of astaxanthin, besides other carotenoids, in *Locusta migratoria* and in *Schistocerca gregaria*. "The demonstration of astaxanthin in locust," they say, "is particularly interesting because, apart from its detection in the retina and eye colourings of birds, this is the first time it has been reported in land animals."

This statement is not quite exact. In 1939 I found this pigment in a mite of the genus *Trombidium*[2]. The pigment is completely extracted by acetone from the mite's body, transferred to petroleum ether and obtained, through evaporation of the solvent, as a red oily residuum (from 3 gm. of mites, 2 gm. of this oil). After saponification, the pigment is taken up again in benzene and after purification by chromatography gives crystals which are intensely violet to red violet under the microscope (2 mgm. of crystals). They give all the reactions characteristic for carotenoids and a peculiar absorption spectrum (a single band at 515 mμ in carbon disulphide and at 500 mμ in pyridine). This result and the chromatographic behaviour and solubility indicate undoubtedly astaxanthin. It is quite probable that this pigment is not infrequent in insects and in other arthropods.

Last year I found a pigment of a similar kind in the potato beetle (*Leptinotarsa decemlineata*). The benzene fraction of the carotenoid pigment gives, with benzene at 70–80°, an orange-yellow zone that splits up in two zones: an epiphasic one, rose-yellow, consisting of β-carotene; an epiphasic one, that is progressing on the column very slowly, eluted with benzene at 70–80° which shows a rose-yellow colour, rose in carbon disulphide, with a spectrum showing one large band with maximum near 497 mμ[3,4]. This pigment looks like the carotenoid pigment that I extracted and crystallized from the fat of a *Phœnicopterus roseus*, the carmin-rose feathers of which perhaps owe their colour to this very pigment. This pigment, which I called 'phœnicoxanthin'[2], shows one adsorption band near 490 mμ in pyridine and differs from astacene both in the position of the adsorption band and in the different solubility and different colour in various solvents.

A full series of investigations is being planned in order to study the metabolism of carotenoid pigments in *Leptinotarsa* fed on various Solanaceæ.

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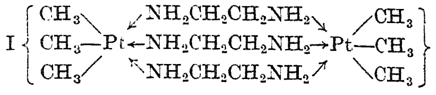
The Trimethylplatinic Group

Pope and Peachey[1] prepared diamminotrimethyl platinic iodide, $(CH_3)_3PtI(NH_3)_2$, readily soluble in alcohol, but sparingly soluble in water. We now find that pyridine added to trimethylplatinic iodide in benzene gives after concentration dipyridinotrimethylplatinic iodide, $(CH_3)_3PtI(C_5H_5N)_2$, m.p. 168°, without previous decomposition, and that similarly from all proportions of dipyridyl and trimethylplatinic iodide, dipyridyltrimethylplatinic iodide, $(CH_3)_3PtI$, dipy, is obtained, insoluble in water, but soluble in chloroform and acetone, m.p. 268–273°. It is apparently unchanged by boiling with dilute acetic acid, hydrochloric acid, ammonia or twice normal sodium hydroxide. It is, however, decomposed by ethylene diamine with formation of sesquiethylenediaminetrimethylplatinic iodide, $2(CH_3)_3PtI.3en$, which may be recrystallized from water. The latter compound can also be prepared from excess of ethylene diamine and trimethylplatinic iodide in benzene. Its structure is probably :



recalling that of iron enneacarbonyl[2]. On refluxing ethylenediamine with excess of trimethylplatinic iodide in benzene, trimethylplatinicmonoethylenediamine iodide, m.p. 204° with decomposition, is obtained. Both ethylenediamine compounds are soluble in water. All four compounds, as also the stable association of trimethylplatinic acetylacetone into double molecules[3,4], are examples of the familiar stability of 6-covalent compounds of quadrivalent platinum.

Less easily classified is the compound obtained from trimethylplatinic acetylacetone or from dipyridyltrimethylplatinic iodide by treatment in benzene with dipyridyl or thallous acetylacetone respectively (m.p. 142–43°, separate and mixed). This compound gives good nitrogen figures for dipyridyltrimethylplatinic acetyl acetone. From a solution of the last-named compound in dilute aqueous acetic acid, dipyridyltrimethylplatinic iodide is precipitated by potassium iodide. The investigation of these and similar compounds is being continued.

The solubilities in water of trimethylplatinic halides, oxide and nitrate[1], closely resemble those of the corresponding silver salts. To use Grimm's expression[5], the trimethylplatinic group is a pseudo-atom of such a nature that other atoms or groups brought into its neighbourhood are frequently subjected to a field similar to that existing in the neighbourhood of a silver atom. We have been unable to find an explanation of this effect.

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[1] Pope and Peachey, *J. Chem. Soc.*, **95**, 571 (1909).

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Glide Bands in Silver Chloride

As already reported[1], polycrystalline sheets of silver chloride show both sharp and diffuse bands of birefringence after plastic deformation. In addition to this effect, plastic deformation causes fine lines to appear on the surfaces of the sheets; these are similar to the glide lines seen on metallic surfaces which have been polished and then deformed. Examination under the microscope with oblique illumination makes it clear that they are steps. This conclusion is confirmed by using the 'shadow-casting' technique developed in connexion with electron microscopy. Measurements made with an optical microscope of the widths of the shadows cast by the steps show that the heights of the most prominent steps are of the order of 4000 A. It would appear, therefore, that the principal, and perhaps the only, mechanism of plastic deformation in silver chloride is glide. In this respect silver chloride differs from sodium chloride, which at room temperature becomes deformed mainly or entirely by kinking[2,3].

Some grains contain a system of birefringent bands with a series of surface steps running parallel to them. However, bands are frequently seen that are not accompanied by a parallel series of steps and, conversely, most surface lines do not run parallel to a system of bands. The connexion between the bands and the steps has been made clear by the following experiments. Rectangular bars of length 25 mm. and approximately square cross-section (1 mm. × 1 mm.) were recrystallized and large portions were found to consist of chains of single crystals joined up end to end. Plastic extension of these specimens produced the phenomena already observed in the sheets; but the true direction of a given set of glide planes could now be determined by measuring the direction of their traces on two non-parallel surfaces. In this way it was established that, whenever a set of glide planes is observed edgewise, sharp birefringent laminations become visible between crossed nicols. As the direction of observation becomes inclined to the glide plane, the boundaries of the glide packets become less sharp; the stress patterns in different glide packets overlap and their details are obscured.

The explanation of the characteristic appearance of deformed polycrystalline sheets may therefore be summarized as follows:

(*a*) Most of the grains in a severely deformed sheet contain two or more sets of operative glide planes.

(*b*) A set of glide planes produces steps on the surface, provided the direction of glide is not parallel to the line of intersection of glide plane and surface.

(*c*) The lamellæ which lie perpendicular to the surface give sharp birefringent bands; other lamellæ give diffuse bands or irregular patches of birefringence.

(*d*) Occasionally a single grain contains two sets of operative glide planes lying perpendicular to the surface. In such a case intersecting systems of birefringent bands are observed (Fig. 2 in ref. 1).

(*e*) In flat strips, either bent or extended by uniaxial tension, the stress system is such that the glide direction in planes lying perpendicular to the surface will tend to be parallel to the surface (at 45° to the direction of the tension). This explains the frequent occurrence of birefringent band systems not accompanied by surface steps.

Experiments to determine the glide system in silver chloride had an interesting result. The orientations of a number of single grains in both sheets and bars were found by taking X-ray back-reflexion Laue photographs. The crystallographic plane of low indices lying nearest to the observed glide plane was not always the same. Out of six systems of glide bands observed in the bars, four were closest to {111} planes, but in the other two systems the closest plane was a {221}. Out of the eight sets of bands observed in plastically deformed sheets, six were closest to {111} planes and two closest to {112} planes. But in none of these cases was there exact coincidence between crystallographic plane and glide plane; the angle between them had an average value of 4·2°, and in one case was as much as 8·1°. This is far greater than the error of the determination (estimated at ± 1·5°). In spite of its non-crystallographic orientation, however, the glide plane was, in all cases except one, found to contain a [110] direction. This behaviour is reminiscent of that discovered in iron by Taylor and Elam[4] in which only the glide direction, [111], is fixed crystallographically, the glide plane being dependent on the stress distribution.

In the tensile experiments on bars of silver chloride, the [110] direction lying in the glide plane was always that one of the six equivalent [110] directions which lay most nearly at 45° to the direction of the tension, or, if there were two glide systems in the same grain, the two [110] directions nearest to the 45° position were selected. Moreover, the glide plane was never more than 9° away from the plane of maximum resolved shear stress containing this favourable [110] direction. This evidence strongly suggests that at room temperature silver chloride becomes deformed by 'pencil glide'[4] in the [110] direction. In iron crystals, pencil glide is connected with the fact that at room temperature the critical stress for glide is the same on three different crystallographic planes, all containing a common glide direction. It seems that this process has not been observed until now in any other crystals. A pencil glide can easily spread from one grain to its neighbour, and this explains the frequent occurrence in the silver chloride sheets of slip lines continuing across grain boundaries.

In single crystals of silver chloride extended by simple tension, Stepanow[5] found glide on planes within 5° of {110} in a [110] direction. This result is in agreement with the conclusions reached above, for in Stepanow's experiments the crystals happened to be prepared with a {100} plane perpendicular to the axis of tension and, under these special conditions, the glide elements to be expected on the present theory are just those that he reported.

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Thickness and Height of the Sodium Layer Responsible for the Strong Yellow Line in Twilight

In a communication in *Nature*[1] in 1940 I gave a short account of results of investigations on "The Atmospheric Layer from which the Yellow Line in Twilight Originates". From a series of spectrograms from the zenith followed by one from near the horizon, the effective screening height (H_s) of the atmosphere and the upper limit (H_u) of the effective sodium layer were determined. Since then, the results of extensive series of observations from Oslo and from the auroral observatory at Trömso have been published[2,3].

All observations give nearly the same value of (H_s) and (H_u). The mean values were found to be $H_s = 49$ km. and $H_u = 110$ km. The results lead to the conclusion that ultra-violet radiation in the region near 2,500 A., strongly absorbed by ozone, is essential for the excitation of the sodium line in twilight.

Photometric measurements of the intensity of the line for successive twilight spectrograms show that as a rule the intensity keeps nearly constant until it suddenly falls to a lower order of magnitude in the course of a short time (Δt), when the shadow produced by the screening layer leaves the upper limit (H_u). If the sodium layer had been evenly effective throughout the whole interval ($H_u - H_s$), the intensity should have decreased gradually during the time it takes for the effective shadow limit to pass from H_s to H_u.

It is therefore legitimate to conclude that the effective sodium layer is restricted to a thin layer, and that the sudden drop of intensity of the D-line begins when the shadow reaches the lower limit of this layer.

Using the zenith observations, the thickness (ΔX) of the layer is given by the formula:

$$\Delta X = (R + H_s) \cos \varphi \frac{\sin h}{\cos^3 h} \cos \delta \sin t \, \Delta t,$$

where R is the radius of the earth, and h, δ and t the height, declination and hour angle of the sun. The value of ΔX has been calculated for twenty series of observations taken at Oslo between October 1942 and April 1943.

The values found for ΔX vary between 8·4 km. and 27·6 km., with an average of 16·2 km. The fluctuations are greater than the possible errors and are, no doubt, to a certain extent real. The values indicate a minimum in December and January and maxima in the autumn and spring. A regular annual variation of H_u and H_s has not yet been found. On an average the sodium layer effective in producing the strong D-line in twilight seems to cover a height interval from about 90 to 110 km.

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Treatment of Paper with Silicon Esters

During an investigation of the possibility of cross-linking nitrocellulose molecules in solution with silicon esters[1,2], some experiments were also made with cellulose itself in the form of filter paper or unsized kraft paper.

The silicon esters used were tetramethyl, tetraethyl and a polymer ethyl ester (boiling range 210–360°). In a first series of experiments, ordinary filter papers (11 cm. diameter) were exposed to vapours of silicon esters at high temperatures and afterwards placed in a funnel, which was then filled with water. Treatment with ethyl ester for 16 hr. at 120° produced a filter paper which was completely impermeable to water for 11 hours. In a second series of measurements the treatment was made with liquid esters instead. Papers which had been immersed in polymer ethyl ester for 4–66 hr. showed a regularly increasing impermeability against water, improving from 1 to 50 hours. Unsized kraft paper gave similar results, whereas experiments with sized paper of different kinds were unsuccessful.

The wet strength of treated unsized kraft paper was three to seven times larger than that of untreated paper. In order to get the treated papers completely wetted, it was necessary to keep them immersed in water for about one week.

It is also possible to carry out the treatment in such a way that no water repellency is observed but a considerable increase in wet strength is obtained. These experiments were made with very thin filter papers known as 'Stilex' (used in the filtration of milk). Their wet strength is very low. With liquid methyl ester we observed in five different experiments increases in the wet strength compared with untreated paper of 16–19 times.

It was also observed that treated filter papers are very resistant towards alkaline solutions. It is possible to filter 10–45 per cent sodium hydroxide.

The water-repellency effect is probably of the same nature as that observed by treating paper or other materials with silicones[3,4,5]. The increase in wet-strength, on the other hand, is very likely caused by cross-links of silicon atoms formed between the cellulose chains.

Further details will be published elsewhere. I wish to express my thanks to Prof. The Svedberg for his interest in the work. I am also indebted to Dr. Ragnar Winbladh for including this investigation among the research projects of Centralbolaget.

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Electrical Breakdown of Organic Insulation by Electro-chemical Reactions

RECENT work on impregnated cellulosic insulating materials has shown that electrical breakdown under moderate D.C. stress is normally of an electrochemical nature. Leakage current is conveyed by ions originating from slight dissociation of the insulating material or from traces of impurities such as moisture or organic acids. The ions on discharge at the electrodes are in a chemically highly active (nascent) condition and may attack the insulation. The attack at the cathode is by nascent hydrogen and, with some forms of insulation, this has serious consequences.

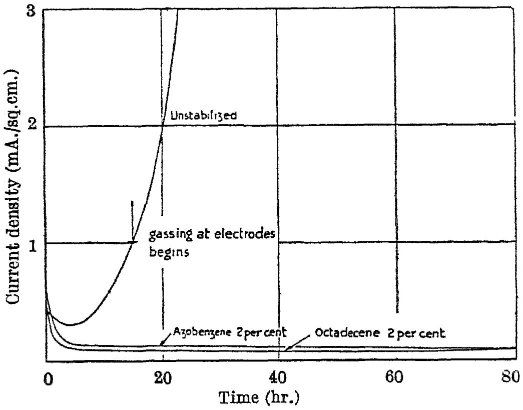
For example, when chlorinated hydrocarbons form part of a dielectric, cathodic reduction leads to release of hydrogen chloride, which itself dissociates in the dielectric, and may result in cumulative increase in current density and chemical attack upon the electrodes or other components of the dielectric.

Egerton and McLean[1] and Berberich and Friedman[2] have shown that the rate of deterioration of capacitors having a dielectric consisting of paper impregnated with a chlorinated hydrocarbon is decreased by the addition of small amounts of the following compounds: quinones, certain nitro-aromatic compounds, maleic anhydride, sulphur, aromatic azo-compounds and benzil. The action of these materials is known as 'stabilization' and has been attributed to formation of a protective film upon the electrodes[1] or a coordination complex between the stabilizer and aluminium chloride produced during the deterioration[2]. It is here suggested that a more likely mechanism is that the stabilizer combines preferentially with the cathodically produced hydrogen, without formation of harmful secondary products, thus shielding the dielectric medium from attack.

The experimental evidence in favour of the latter theory is as follows.

(1) All the substances listed as stabilizers are readily capable of reduction, and electrolytic reduction is found to take place under suitable conditions. Thus, we have found that when capacitors which have been stabilized with anthraquinone are opened after use under D.C. stress, under conditions which prevent reoxidation, the reduction product, oxanthranol, is produced. The same substance is found at the cathode on electrolysing acidified alcohol containing anthraquinone. Azobenzene is similarly reduced to hydrazobenzene.

(2) Trichlorbenzene – alcohol mixtures containing a little moisture, when electrolysed at room temperature, increase rapidly in conductivity, with formation of hydrogen chloride, after an initial induction period. Addition of a stabilizer greatly increases the induction period, irrespective of whether aluminium, tin or platinum electrodes are used. Mean conductivity – time curves using platinum electrodes are shown in the accompanying diagram.



Electrolysis of trichlorbenzene – alcohol mixture (50/50 vol. + 2 per cent water) with and without addition of azobenzene or octadecene using platinum electrodes. Stress, 150 volts (D.C.) per cm.

(3) Paper dielectric capacitors impregnated with chlordiphenyl are capable of stabilization, even when made with platinum electrodes. The lives of such capacitors have been extended more than ten times by the addition of azobenzene or octadecene.

(4) Readily hydrogenated aliphatic hydrocarbons, for example, octadecene (see (2) and (3) above), are effective stabilizers. Compounds of this type have not previously been cited as stabilizers and were investigated because of their unsaturated character and ease of hydrogenation.

It can be predicted that any readily reducible compound will stabilize, provided that neither it nor its reduced form appreciably ionizes in solution in the insulating material.

A detailed account of this work will appear elsewhere and further work is in progress.

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Beta Spectrum of Tritium

The β-spectrum of tritium ($_1H^3$) is of particular interest because: (1) the relatively simple structure of the $_1H^3$ nucleus makes it well suited to a test of the Fermi theory of β-decay; (2) the unusually low energy of the β-particles means that the shape of the spectrum near the upper limit is an extremely sensitive function of the rest mass of the neutrino if the Fermi theory is confirmed; (3) a theoretical discrepancy[1] exists between the half-life[2] and the upper energy limit, as recently measured[3]; (4) the mass difference ($_1H^3$ — $_2He^3$) can be accurately determined.

We have developed a new technique for rapid and accurate detection and energy measurement of β-rays, conversion electrons, γ-rays and X-rays (including K-capture radiation) from weak sources. The method, applicable to radiations of energy of 0·5–150 keV., uses a proportional counter, containing an argon – methane mixture at a pressure of one atmosphere or more, connected to a linear amplifier of high gain. The output pulses are applied to the deflecting plates of a cathode ray tube and recorded by a moving-film camera. The size of the pulses is a true relative measure of the energy of the ionizing radiation involved, provided that the range of the ionizing particle within the counter is small compared with its dimensions. The histograms of such pulses show that the resolving power of the apparatus is very good.

Radiation of known energy is used to calibrate the apparatus; for example, the fluorescence radiation of copper has been found to be very suitable. The counting system has been checked over the range 6–50 keV. with radiation from radioactive sources and with X-rays, and very good agreement with known values was obtained. The large Auger effect in argon[4] ensures that practically the whole energy of a photon is converted into the kinetic energy of the photo-electrons which it releases from the gas.

The amplifier gives a measurable pulse about three times the peak noise voltage for a charge of 1,500 electrons at the first grid. Thus, with a gain in the gas of as little as 100—ensuring strict proportionality—a measurable pulse is secured from the formation of 15 ion pairs; the system, therefore, can readily measure electron energies down to 500 eV.

Fig. 1 gives a typical calibration spectrum of the fluorescence X-radiation of copper, showing the $K\alpha$ and $K\beta$ groups clearly resolved. The counter contained sufficient tritium gas to give about 5,000 counts per minute, and the X-radiation is superimposed on part of the $_1H^3$ β-spectrum; the distribution shows that a pulse size of 47·5 units (arbitrary scale) corresponds to the $K\alpha$ groups of copper, taken[4] as 8·01 keV. Fig. 2 shows the tritium spectrum for the range 1–18 keV. taken under the same conditions. The background, about 15 counts per energy interval, has been subtracted and the energy scale set up according to the above calibration; about 40,000 pulses are analysed. The upper limit is found to be 16·9 ± 0·3 keV., which is considerably higher than a recent estimate[3] of 11 ± 2 keV.

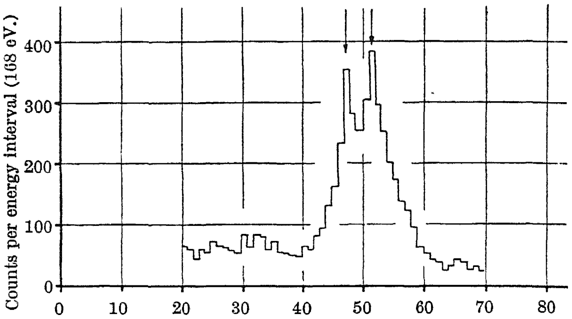

Fig. 1

The calculated Fermi distribution for $_1H^3$ of end-point $\sim$ 17 keV. shows a maximum at about 2 keV.: a maximum appears on our experimental curve near 2·5 keV., but we find that it is definitely rather wider than the maximum of the theoretical curve. We have made various experimental tests which confirm that the shape at low energies is not due to absorption of hydrogen by the wall with consequent loss of range of the emergent electron. The radioactive gas could be pumped off readily and completely, and the shape of the spectrum was found to be independent of the ratio of surface to volume for the counter. Taken with two cylindrical counters of effective lengths 12 cm. and 4·5 cm. and diameters 6·7 cm. and 2 cm. respectively, the results were identical within experimental error. The histograms given here were obtained with the larger tube. The range of the most energetic electrons of $_1H^3$ is negligible compared with the dimensions of this counter. It seems certain that in this work the departure from agreement with Fermi at low energies cannot be ascribed, as in a number of previous spectrographic investigations with other sources, to the ordinary limitations, in particular the thickness and support of the source and the absorption at the window of the detector. This disagreement may be rather important in view of the relative simplicity of the Fermi theory for the light nucleus $_1H^3$.

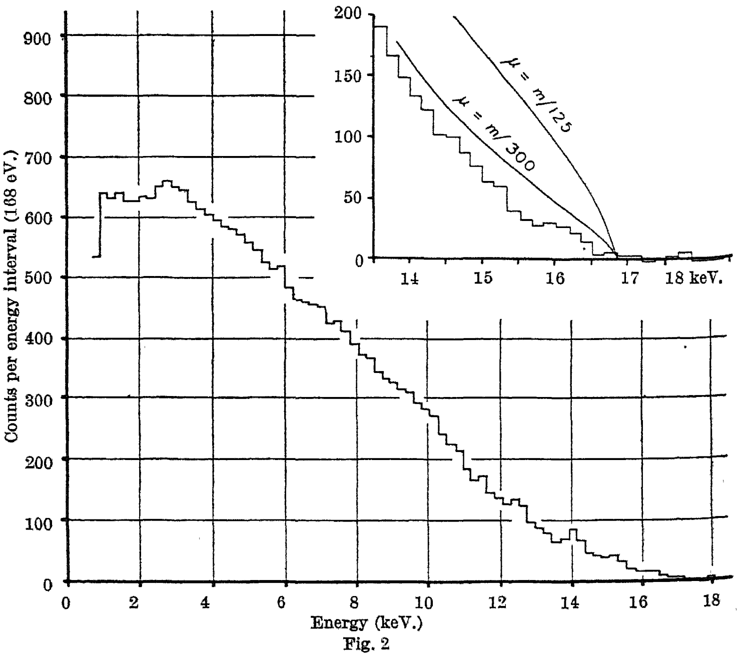

Fig. 2

We have considered the possibility of the spectrum being complex, but its shape seems to rule out such an explanation. The detector is such that γ-rays following emission of β-particles of a hypothetical softer group would have given rise to a readily observable discontinuity on our histograms, since the efficiency of detecting such γ-rays would be $\sim$ 25 per cent. The life-time of the excited state of ${}_2He^3$ would have to be appreciably greater than the life-time of ${}_1H^3$ to escape detection.

In view of the above considerations, it is possible to justify the application of neutrino theory to the upper end of the spectrum in the usual manner. However, we have shown in the inset figure two curves calculated for neutrino masses $\mu = m/125$ and $m/300$, and comparison of these with experiment seems to indicate that μ is less than $m/300$.

Since there is no evidence of γ-radiation following the β-emission, we can write the mass equation (atomic) as

$$ {}_1H^3 - {}_2He^3 = 0{\cdot}000018. $$

It is a pleasure to thank Prof. P. I. Dee for his valuable advice throughout the work. We are grateful to Mr. B. Touschek for elucidating various theoretical points.

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Velocity of Photons

I AM seeking an answer—or a reference to an answer—to an apparent paradox arising out of the theory that light is transmitted in the form of photons, which may be illustrated by the following concrete example.

Atoms of sodium on Sirius, vibrating so as to give out a definite spectral line, send out photons each of which contains the amount of energy ($h\nu$) corresponding to such vibration. These photons, therefore, are identical in all respects, since their energy content is dictated solely by local conditions and clearly cannot be influenced by what may be their ultimate targets, if any. Two such photons are directed towards the solar system, and one arrives at the earth which is approaching Sirius at 30 miles per second, and the other on Mars which happens to be receding from Sirius with the same velocity. What physical factor causes these photons to give different optical effects since (*a*) their internal energies are identical, (*b*) their speeds are also identical, since they arrive at their targets with the velocity (absolute and relative) of light, which is independent of the motions of source and observer ?

I have searched in vain for any explanation of the Doppler effect which recognizes (*a*) that light moves in the form of photons, and (*b*) that the velocity of the photons is independent of that of their source.

Personally, I can see no answer to this query unless the theory as to the travel of light in the form of photons is profoundly modified.

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Latitude Effect and Meson Decay

IT has been pointed out recently[1] that the height of the atmospheric layer (100 mb.) in which most mesons are supposed to be produced decreases from the equator towards the poles. The decay of the mesons causes a corresponding increase in cosmic ray intensity.

A first calculation of this effect based on a decay constant[2,3] $L = 5$ km. seemed to indicate that the greater part of, if not all, the latitude effect might be explained thus. A more precise estimation of the 'atmospheric latitude of effect' as distinguished from the geomagnetic can be obtained as follows. The altitude of the 100-mb. level varies not only with geographic latitude but also with the seasons. It is assumed that the seasonal effect of cosmic rays as observed in latitudes where the geomagnetic effect is small, if not nil, is entirely due to these variations. This is called the 'atmospheric seasonal effect'. Further, the 'atmospheric latitude effect' is defined as the variations in cosmic ray intensity caused by the differences at different geographic latitudes in the yearly averages of the heights at which mesons are produced; all measurements having been reduced before to standard atmospheric pressure. The ratio of the two effects can be obtained by comparing the seasonal variation of the meson-producing layer with its average latitudinal variation between the equator and the latitude under consideration. The influence of a differing energy spectrum is neglected.

Measurements with shielded ionization chambers at sea-level[4,5] and tables and graphs of the altitude of the 100-mb. level[6,7] supply all the data required. These are tabulated in columns 1, 2, 3, 4.

1		2	3	4	5	6	7	8
Sydney	34° S.	0·20	2·0	1·3 [4] 1·1 [5]	1·3 1·7	1·5	3·0	13
Vancouver	50° N.	0·35	1·2	3·1 [4] 1·2 [5]	3·1 1·8	2·5	3·0	14

Column 2 : Difference summer–winter of the height of the 100-mb. level in km. (dH).
3 : Difference equator–40° lat. of same level divided by value of column 2.
4 : Observed difference summer–winter as percentage of cosmic ray intensity.
5 : Adjusted column 4.
6 : Average of column 5 (dI/I).
7 : Atmospheric latitude effect equator–40° lat. as percentage of total cosmic ray intensity, obtained by multiplying columns 6 and 3.
8 : Decay constant L in km. obtained by dividing column 2 by column 6.

The values for some of the seasonal variations of cosmic rays have to be adjusted for the difference in the period over which they and the stratosphere data were averaged (column 5). The decay constant L was calculated from the relation $dI/I = -dH/L$, in which I is the cosmic ray intensity and H the height. Taking into consideration the wide differences possible in the measurements of the heights at times as well as localities far removed from the cosmic ray measurements, it is satisfactory to find that the results obtained for the decay constant lie within the range[8,9] of 9–19 km. of the most reliable determinations. In conclusion, it can be stated that the atmospheric latitude effect is about three per cent of the total intensity, that is, one third of the total latitude effect between the equator and the knee at sea-level. This reduction of the geomagnetic latitude effect, if confirmed, will require a revision of the energy spectrum of the primary cosmic rays.

The east–west effect, the nearly constant geomagnetic latitude of the knee, demonstrate also that a great part of the latitude effect is of magnetic origin.

When an attempt was made to obtain accurate corrected values for the geomagnetic effect alone, it was found that the necessary experimental data did not exist. The previously used temperature correction[4,5] presupposes at least a very high correlation between sea-level temperature and the altitude of the 100-mb. level, which is not proved. On the other hand, this correlation could mask a geomagnetic effect extending beyond the knee, the correlation between sea-level temperature and latitude being of the order of 0·9 and more.

The height of the meson-producing layer will depend not only on latitude and season but also on other local meteorological and geographical factors, distribution of land and sea, mountains and so on. To achieve a reliable and accurate correction, it is clearly necessary to obtain simultaneous cosmic ray and high-atmosphere data at the same locality. A new world-wide survey made under these conditions might reveal that some of the unexplained features of Compton's can be explained as a 'local atmospheric effect' and do not represent a variation in primary intensity.

Results obtained during the 1948 cruise of the *Wyatt Earp*, the ship of the Australian Antarctic Expedition, will be published shortly in the *Australian Journal of Scientific Research*. The measurements extend to within 200 miles of the magnetic south pole.

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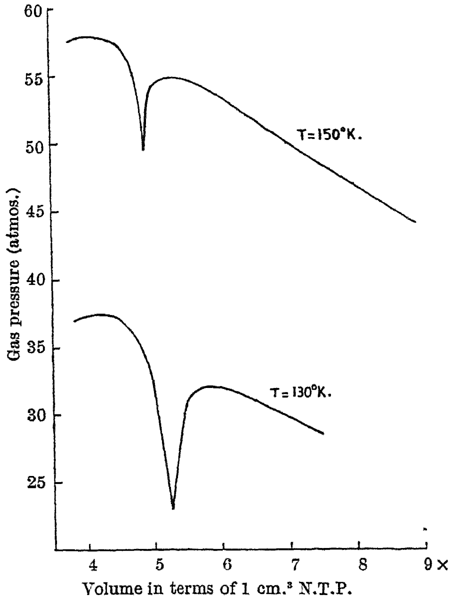
An Approximate Equation of State

In a previous communication which appeared in *Nature*[1], Prof. Max Born and Dr. H. S. Green gave an account of a general kinetic theory of condensed matter (see also refs. 2–5). A new equation of state was derived which covers both phases, liquid and gas. Some numerical results (to be published in detail elsewhere) have now been obtained.

The theory shows that the difference between the liquid and the gas corresponds to the existence or non-existence of real roots of a certain transcendental equation. This was in the original form an integral equation, but has now been reduced, by using a suitable expansion, to an algebraic equation with a unique analytic continuation, so that the definition of the complex roots is unambiguous.

The theory of condensation developed by Mayer[6] and others[7,8] is confirmed by the present theory to the extent that a divergence of the cluster series is found, which is intimately associated with the process of condensation. Concerning the exact point at which this divergence occurs, detailed calculations do not confirm Mayer's contention that it happens at the density of the saturated vapour. The isotherm is continued into the metastable region above this density, rising to a maximum and falling to a subsequent minimum as the density is increased, much in the way foreshadowed by van der Waals more than fifty years ago. The point of divergence is found to be at the minimum of this curve, which separates the metastable states of the liquid from those of the gas.

A numerical computation has been carried out for argon using the Lennard-Jones[9] potential; two isotherms have been calculated, one for the empirical critical temperature ($T = 150°$ K.) and one for a lower one ($T = 130°$ K.). The accompanying graph shows the result.



Concerning the absolute values, one can compare the experimental critical point with the situation of the maximum in the gas region of the first curve. The results are given in the table, for 1 cm.³ of gas at N.T.P.

	Experimental	Calculated
Pressure	50 atmospheres	54 atmospheres
Volume	0·0034 cm.³	0·0052 cm.³

A conspicuous feature of the curves is the fact that for small volumes they do not ascend steeply but have a maximum and fall again. This may be due to the crudeness of the approximation actually employed (namely, only the first three roots of the transcendental equation were taken into account). But it seems to be quite possible that it is an indication of another range of unstable states separating the liquid from the solid. This has to be investigated.

Exact numerical prediction would need a great amount of computation. It seems more important to use the same method for calculating the radial distribution function, which can be compared directly with X-ray experiments. This will be done in a paper in due course.

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ELECTRON OPTICAL OBSERVATIONS ON CHROMOSOME STRUCTURE IN RESTING CELLS

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PRESENT knowledge of chromosome structure is based chiefly on observations made on fixed preparations of large *mitotic* chromosomes or of the so-called giant chromosomes in the salivary gland of certain diptera with microscopes utilizing visible or ultra-violet light[1]. A preliminary account has recently been published of electron microscope studies on large plant chromosomes[2]. Little or nothing is known concerning the structure of chromosomes in *resting* cells beyond the fact that they are present in the form of exceedingly slender threads (chromonemata) or of the so-called chromatin network[3].

Following preliminary observations, made in our laboratory in collaboration with Miss Judith Schryver[4], we have studied in some detail the chromatin structure present in the resting nucleus of calf thymus lymphocytes. An RCA electron microscope of the universal type, equipped with a self-biased electron gun and an objective pole piece corrected for asymmetry[5], was used in this work.

Pure suspensions of thymus lymphocytes were obtained by mincing fresh or frozen tissue under 0·9 per cent sodium chloride solution, straining the resulting milky suspension through gauze, sedimenting the cells in a centrifuge at low speed, and resuspending them in physiological salt solution. The intact lymphocytes have a diameter of approximately 7 μ, while the nuclei measure 5–6 μ. Owing to their relatively large size, the cells as well as the nuclei are opaque when examined directly in the electron microscope. Chromium-shadowed replicas[6] prepared from slowly dried, intact thymus lymphocytes show a *pitted* surface. Its appearance may, to some extent, reflect the underlying structure of these cells, or it may represent an artefact produced by shrinkage upon drying in a high vacuum.

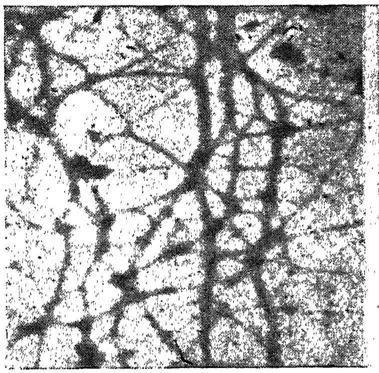

Fig. 1

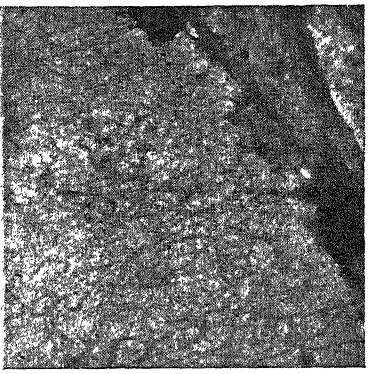

Fig. 2

Fig. 1. Chromatin network of thymus lymphocyte, prepared by rupture in high vacuum. Overall magnification, × 20,000

Fig. 2. Ultra-fibrils, obtained by lanthanum acetate treatment of chromatin network of thymus lymphocyte. Overall magnification, × 20,000

When the lymphocytes are ruptured by quick drying in a special, high-vacuum chamber, or when they are damaged mechanically by placing a suspension of the cells in physiological salt solution in a Waring blendor, a mass of cellular contents escapes through the ruptured cell membrane. After the cytoplasmic components of this mass, which usually remains connected with the 'ghost' of the cell, have been dissolved by washing with physiological saline, the chromatin nature of the residue adhering to the collodium film on the copper screen can be demonstrated with the aid of nuclear stains, for example, acetocarmin or Feulgen stain, and the optical microscope. The examination of the same material, but without fixing or staining it, in the electron microscope reveals a loose mesh of cross-linked fibres of indeterminate length and of varying width, ranging from about 200 A. to 700 A. (Fig. 1). With the exception of dense spots which are situated at cross-over points of the fibres, little, if any, fine structure may be discerned in them. It is believed that the material shown in Fig. 1 represents the *chromatin network* as it exists in the nucleus of resting cells, in agreement with the classical view[3] according to which the 'thread type' nuclei of the cells of glandular tissues consist essentially of a reticulum of chromatin threads distributed in a fluid nucleoplasm. While the nucleoprotein nature of these fibres appears established through their origin, solubility, staining as well as other chemical properties, and their high density towards electron beams, their relationship to or identity with the *chromonemata* or 'resting chromosomes' remains to be determined. The examination in the electron microscope, at low power, of the particles isolated from thymus tissue by repeated use of the Waring blendor at low and high speed according to Mirsky and Ris[7], and designated as 'resting chromosomes' by these workers, indicates that they represent random fragments of the chromatin network resulting from mechanical shearing action rather than preformed units of well-defined structure.

Lanthanum salts are known to possess a high affinity for nucleic acid and have previously been used for analytical purposes and ultra-violet microscopy of chromosomes (cf. T. Caspersson[1]). When thymus lymphocytes are treated with lanthanum acetate after the cells have been ruptured mechanically or by exposure to a high vacuum, the fibres composing the chromatin network are further resolved into bundles of fine *ultra-fibrils* of fairly uniform thickness of 80–100 A. (Fig. 2). In addition, the

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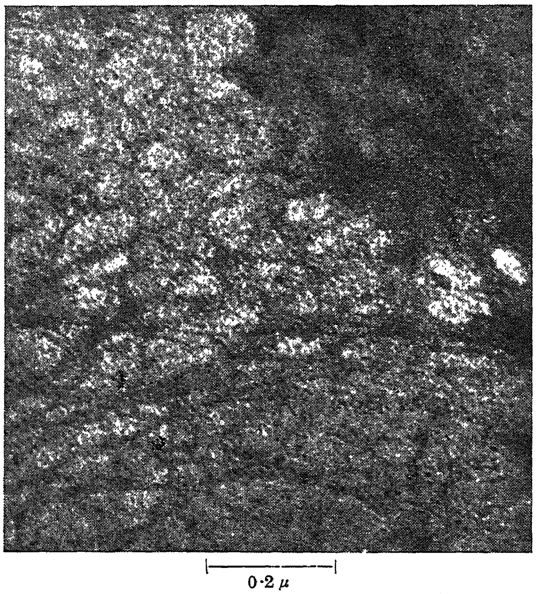

Fig. 3. Photographically enlarged area from Fig. 2, showing fine structure of lanthanum-stained ultra-fibrils. Overall magnification, × 80,000

lanthanum reagent acts as an 'electron stain' on the nucleoprotein ultra-fibrils and permits the detection of details which cannot be seen in unstained preparations. (Structural details of muscle and collagen fibrils have been brought out by electron-staining with phosphotungstic acid by F. O. Schmitt *et al.*) Carefully focused electron micrographs of lanthanum-treated fibrils show that they possess definite fine structure of a high order of regularity. This is evident from Fig. 3, which represents a photographically enlarged area of Fig. 2.

The inspection of a number of electron micrographs of this type suggests that the banded appearance of the lanthanum-stained ultra-fibrils is produced by the *coiling* of a fine thread to form long helices. The apparent width of the individual 'bands' or 'disks' is about 30–40 A., spaced at approximately equal intervals from each other. It is of interest to note that X-ray diffraction measurements on a synthetic albumin thymonucleinate complex[8] and ultracentrifuge and diffusion experiments on thymonucleohistone particles in 0·8 *M* sodium chloride solution[9] have yielded estimates for the width of such molecules of 23 A. and 40 A. respectively. Thus it would appear possible that the structures reproduced in Figs. 2 and 3 represent spirals formed by individual desoxyribonucleoprotein molecules in combination with lanthanum ions. A fine structure of this type has recently been postulated on theoretical grounds by one of us[10].

This work was supported by a grant from the Brooklyn Cancer Committee, the assistance of which is gratefully acknowledged.

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[10] Stern, K. G., *Yale J. Biol. and Med.*, 19, 937 (1947); *Scientia*, 41 (6th Ser.), 74 (1947).

EVOLUTION OF THE DENTITION OF THE ORANG-UTAN

DURING his searches for the remains of the forerunner of man, beginning in 1887 and covering a span of more than twelve years, the late Prof. Eugène Dubois collected prehistoric and fossil teeth of the orang-utan in the islands of Sumatra and Java. Dubois has always been very guarded in his comments on the prehistoric teeth; but the fossil have received much attention because they were ascribed to *Pithecanthropus erectus*. The results of a recent study made by me on this material* are summarized here.

Dubois' explorations started in prehistoric caves in the Padang Highlands, Central Sumatra. The cave fauna appeared to be characterized by the relative abundance of the orang-utan (now confined to the northern parts of the island, and to Borneo), and contained no extinct species. In general, the cave teeth differ from their recent homologues by their greater average size. In several cases I find that the differentiation which the species has undergone since the deposition of their teeth in the caves has proceeded to a stage equal to that of good subspecies.

More than three thousand isolated subfossil teeth of the orang-utan were collected by Dubois in central Sumatra, representing some three to five hundred individuals. The study and statistical analysis of this collection has revealed certain interesting trends in the evolution of the dentition. They stamp the prehistoric orang-utan, which may be known as *Pongo pygmæus palæosumatrensis*, as a larger and more simian form than the recent orang. On the average, the teeth of the prehistoric orang-utan are 16 per cent larger than the recent. The lateral incisors, both in the upper and in the lower jaw, were relatively less reduced in size. The canines were larger and less hypsodont than the recent, and the sexual difference in size was even more pronounced in the prehistoric than it is in the present-day orang-utan. The anterior lower premolar was larger relative to the posterior. The excess in size of the second molar over the first and the third, a typically simian feature that is met with in early stages of the evolution of the hominid dentition, was more pronounced in the prehistoric orang-utan than it is now.

The two upper molars from the middle Pleistocene at Trinil in Java ascribed to *Pithecanthropus erectus* by Dubois have been stated to belong to an orang-utan by Miller, Weidenreich and Von Koenigswald. The careful study of the original specimens leaves no shadow of doubt as to their belonging to the orang-utan. They can be determined as representing M^3 sin. and M^4 dext. respectively, most probably derived from one and the same individual. The fossil Javanese teeth are not larger than their recent homologues.

Pleistocene teeth of the orang-utan have been described from southern China by Pei, Von Koenigswald and Weidenreich. In contradistinction to the Pleistocene teeth from Java, however, the fossil Chinese teeth are decidedly larger than the recent, and they even differ from those of *Pongo pygmæus palæosumatrensis* in their distinctly larger size. A lower canine from the Hoshangtung cave in Yunnan,

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* "Prehistoric Teeth of Man and of the Orang-utan from Central Sumatra, with Notes on the Fossil Orang-utan from Java and Southern China." By Dr. D. A. Hooijer. *Zool. Med. Museum, Leyden*, 29, 175–301, pls. I-IX, 2 diagrams.

China, described by Weidenreich, is made the type of a new subspecies, *Pongo pygmœus weidenreichi*, on account of its being still bigger and less hypsodont than its homologue in *Pongo pygmœus palœosumatrensis*. It has thus become evident that the orang-utans which roamed the Pleistocene forests in southern China and in Java respectively were racially different, the continental form being larger than the Javanese. The fossil canine from Yunnan is structurally ancestral to that of the subfossil Sumatran orang-utan; but the relationship between the fossil Chinese and the subfossil Sumatran race cannot be regarded as firmly established on the base of isolated teeth. At any rate, the Pleistocene forerunner of *Pongo pygmœus palœosumatrensis* must have been larger than that of Java, the island in which the orang-utan is now extinct. The Javanese orang-utan was already of the small size of the present-day Sumatran and Bornean orang-utan in the Pleistocene, and it might very well have decreased in size still further up to the present, a condition that is paralleled by other species in which the record is more complete.

The dental characteristics of the recent orang-utan, which have been used in so many comparative studies on the dental anatomy of man and the apes, have now been shown to be the result of an evolutionary change dating from the emergence of the species early in the Pleistocene. The prehistoric Sumatran and the fossil Chinese orang-utan are still further removed in dental structure from man in the points which distinguish the recent orang-utan dentition from that of modern man. D. A. HOOIJER

CARNEGIE TRUST FOR THE UNIVERSITIES OF SCOTLAND

THE forty-sixth annual report of the Carnegie Trust for the Universities of Scotland, Dunfermline, covers the academic year 1946–47 and again includes as appendix the new scheme for the award of fellowships and scholarships which came into effect on October 1, 1947. Grants made under the eighth quinquennial distribution for the period October 1, 1947, to September 30, 1952, and detailed in an appendix, include £33,650 to the University of St. Andrews, £13,350 to University College, Dundee, £70,000 towards the erection of the final portion of the Chemistry Institute at the University of Glasgow, £47,000 towards the cost of the new Chemistry Department at the University of Aberdeen, £23,000 for library expenditure and £25,000 for capital expenditure on the university schemes on the Bush and Dryden estates at Edinburgh, the grand total being £234,000 to the universities and £36,000 to extra-mural colleges. Special attention is directed to the observations in the report on assistance to students. The Executive Committee, examining the new situation created by Circular 106 of the Scottish Education Department, considered that until the amount of the bursary awarded by the education authorities had been ascertained for each individual applicant to the Trust, it would be premature to make any extensive alterations in the system adopted for the award of Carnegie Trust grants. Nevertheless, the Executive Committee expected that a turning point in the administration of the Carnegie Trust, so far as half its annual income is concerned, may have been reached, and that very considerable sums at present absorbed in assistance with class fees will be liberated for new projects. The amount disbursed for this purpose during 1946–47 was £51,072 to 3,068 beneficiaries, as against £55,109 to 3,250 beneficiaries in 1945–46.

In the report on the work of investigators during the year, special reference is made to the work of the following: J. L. Miller, on various aspects of high-voltage engineering; Eric Reid, on the diabetogenic principle of the anterior pituitary body; A. M. Mathieson, on the use of X-rays for the study of the structure of complex sulphur compounds and of anthracene; J. C. Robb's measurement of the rate of addition of atomic hydrogen to an unsaturated hydrocarbon; and N. Grassie, on the thermal degradation of high polymers of the polyvinyl type. N. Grassie has devised a molecular still of very high performance and has thrown much light on the mechanism of depolymerization; R. I. May has made rapid progress in the study of polymerization in the gas phase; and A. McLaren in investigations of the role of radicals in polymerization. Mention is also made of the 'cruciform' macromolecule compounds, obtained by C. W. Youngson, of D. Ellis and G. T. Dickson's results in the study of the molecular structure of colchicine, and of S. C. Reid and R. C. Stuart's work on the chemistry of mandelic acid derivatives. In his work on the Silurian rocks of the Pentland hills, Dr. A. Lamont has made a major contribution to geology. Dr. D. B. McIntyre has completed his work on the north-west part of the Loch Doon Plutonic complex and is now studying granitization phenomena in the Alps. Dr. N. Holgate has investigated the igneous rocks of the Glen Bervie complex, and Mrs. E. M. Knox's research has revealed the presence of several new types of microspores in the coals of the Limestone coal group of both the Fifeshire coalfield and the Central coalfield of Scotland.

The report of the Superintendent of the Laboratory of the Royal College of Physicians refers to Lieut.-Colonel W. F. Harvey's microscopic investigation of his collections of sections of human tumours, Dr. J. C. Lees and T. W. Lees' tests in mice of the tumour growth-inhibiting power of ten representative drugs, Dr. J. C. Lees and W. W. Park's collection of data regarding 120 cases of carcinoma of types usually affecting older patients but occurring at 30 years or less, and Dr. E. K. Dawson's histological investigations. Work under Dr. W. O. Kermack has been directed chiefly to the synthesis of compounds of possible interest as chemotherapeutic agents; Miss B. Cairns has worked on the synthesis of halogenated 1-azanthracenes, such as 9-bromo-2 : 4-dimethyl-1-azanthracene, and Dr. McKail on benzthiazoles containing an amino-group in the benzene ring. Mr. Bryce Douglas extended his research on *p*-phenanthrolines and related compounds to the synthesis of derivatives containing a basic side-chain in the 4-position and a chlorine atom in the 9-position. Dr. R. A. Miller is working on the determination of the conductivity and chloride content of human mother's milk throughout the lactation period both under normal and abnormal conditions, and Col. Glen-Liston and Dr. F. Chisholm's work on leucorrhœa has been completed, as has Dr. R. S. Barclay's work on the course of mortality and fertility in Scotland during the past eighty years.

The appendixes include a list of publications by fellows, scholars and recipients of grants received since September 30, 1946.

FIFTH COMMONWEALTH ENTOMOLOGICAL CONFERENCE

BECAUSE of the War, thirteen years have elapsed since the last Commonwealth Entomological Conference was held in London, and there is no doubt that the recent fifth Conference, which ended on July 29, has been the best attended and one of the most successful of the series. There were forty-two delegates, representing the United Kingdom, Canada, Australia, New Zealand, India, Southern Rhodesia and various Colonial territories, and the open meetings were attended also by large numbers of entomologists from Great Britain and overseas.

The first day was devoted to a discussion on insecticides and their application. This is the first time that this topic has appeared on the agenda of a Commonwealth Entomological Conference, and it was the only one to be given a full day.

The discussion on recent developments in insecticides was opened by Dr. R. A. E. Galley, scientific secretary to the Insecticides Development and Research Committee. He summarized the present knowledge on synthetic insecticides, many of which are still in the early experimental stage. Particular interest lies in the development of systemic insecticides which are absorbed by plants and thereafter toxic to insects which feed on them.

Dr. V. B. Wigglesworth, director of the Unit of Insect Physiology of the Agricultural Research Council, in a discussion on the mode of action of the new insecticides, said that D.D.T. if injected internally was almost equally toxic to insects and vertebrates. The reason that the former are so readily affected if they come in contact with D.D.T.-treated surfaces, while the latter are unharmed, is because of the readiness and rapidity with which absorption takes place through the insect cuticle. An account of Canadian experience with the new insecticides was given by Mr. W. A. Ross, of the Canadian Department of Agriculture, who stated that, of them, D.D.T. was the one most extensively used. Because of the great increase in the importance of orchard mites following the use of D.D.T., a search for efficient acaricides is one of the principal problems of fruit insect research in Canada. Several promising ones have already received preliminary investigation.

A discussion on the application of insecticides from the air was opened by Dr. D. L. Gunn, of the Anti-Locust Research Centre. After mentioning the question of costs, Dr. Gunn spoke of the importance of ensuring a sufficiently homogeneous coverage of the target area. He pointed out that while a great deal of publicity has been given to aircraft spraying, and while in certain circumstances it would undoubtedly prove of value, little is yet known as to whether it can establish itself in competition with other methods.

Dr. W. R. Thompson, of the Commonwealth Bureau of Biological Control, who was to have opened the discussion on the biological control of insects, was unable to be present, and this session was opened by Mr. A. B. Baird, of the Canadian Department of Agriculture. Mr. Baird gave an account of the work of the Bureau of Biological Control since the last Conference, and spoke also of projects, mostly involving forest insect pests, with which he had been associated. Dr. W. Cottier, of New Zealand, followed with an account of the successful biological control of the small cabbage-white butterfly (*Pieris rapæ* L.) in New Zealand, and Dr. R. H. Le Pelley described the steps leading up to the control, by means of introduced parasites, of the coffee mealy bug in Kenya. This insect has at different times passed under different names, and this led to the search for parasites, made in the early stages of the investigation, being misdirected. When it was eventually realized that the injurious mealy bug was an undescribed species, native to the adjoining territory of Uganda, the parasite search became properly directed and was successful.

Some account of the general principles of the biological control of weeds by means of insects was given by Dr. D. Miller, of the Cawthron Institute, New Zealand. He also outlined particulars of some of the weed control projects which have been undertaken in New Zealand. These have been concerned with gorse, *Acæna* sp., and ragwort.

Mr. A. H. Strickland of the West African Research Institute, Tafo, Gold Coast, presented an able summary of special techniques relating to the estimation of insect populations in the field. He is of the opinion that little purpose is served by carrying out insect census work unless a preliminary detailed study has been made of the biology and habits of the species of insects concerned.

The discussion on recent developments in the control of stored products insects was opened by Mr. F. N. Ratcliffe, of the Division of Entomology of the Australian Council for Scientific and Industrial Research. He confined his remarks to wheat insects, and mentioned that the exploitation of D.D.T. and benzene hexachloride against grain insects is at present limited by the prevalent fear of their toxicity to human beings. In conclusion he stressed the importance of scientific men who work in this field having a knowledge of the manipulating conditions of the grain industry.

The subject of tsetse fly research and control was opened by Dr. T. A. M. Nash, and Dr. K. R. S. Morris took a prominent part in the discussion. Dr. Nash indicated the main lines in which research has been conducted ; he remarked that each of the seven most important species of *Glossina* has different vegetational and climatic requirements, host preferences, and characteristic behaviour. While many methods of control have seemed promising, they have usually failed to produce complete elimination of the fly, with the result that as soon as control measures are relaxed, the fly density starts to rise.

In a discussion of the need for plant quarantine on a continental basis with special reference to Africa, delegates from various African territories gave particulars of the plant quarantine practice in their areas. The danger that might arise from uncontrolled air transport was emphasized.

Dr. B. P. Uvarov, who opened the discussion on locusts and grasshoppers, said that the outstanding result of the past twenty years of locust investigation is the firm establishment of the principle of outbreak areas, where the initial transformation of the solitary phase into the gregarious phase occurs and the first swarms of a plague-cycle are formed. While of recent years great strides have been made in discovering and applying effective palliatives, these must not be regarded as the end-point of the investigation ; a radical solution of the problem must be sought in outbreak prevention, which needs more fundamental research.

Following the discussion on locusts and grasshoppers, the remaining part of the last afternoon was spent considering the recommendations of a Termite Sub-Committee which had been set up at an early stage of the Conference. These recommendations stressed the urgent need for research work on termites, particularly in the Colonies.

During the course of the Conference, delegates visited Whipsnade, Rothamsted Experimental Station, the Pest Infestation Laboratory of the Department of Scientific and Industrial Research at Slough and the new entomological Field Station of the Imperial College of Science and Technology at Silwood Park. These visits, combined with certain social occasions, served to give delegates that chance of informal discussion which is perhaps the most valuable part of a conference of this nature.

FOSSIL FLORA OF KERGUELEN ISLAND

THE biological interest of Kerguelen Island (latitude 49° S., longitude 69° E.) has been well known to botanists since 1847, when the young Joseph Hooker, as junior surgeon in Ross's famous voyage to the Antarctic in the *Erebus and Terror*, contributed a description[1] of the botany of this island gained as the result of the expedition's first winter in the southern hemisphere (May–July, 1840). The extreme poverty of the flora was its most noticeable feature, only eighteen species of flowering plants having been found by Hooker, and of these only eight covered any considerable expanse of ground. These included the remarkable endemic crucifer, *Pringlea antiscorbutica* (the Kerguelen Island cabbage), and a peculiar umbellifer related to the 'balsam bog' of the Falkland Islands. In comparable latitudes in the northern hemisphere much richer floras were known to occur, the vegetation of Spitsbergen, for example, containing records in 1847 of forty-five species of flowering plants on a comparable area. This, coupled with the isolated position of the island in the middle of the Antarctic Ocean, almost equidistant from South Africa and from Australia, the presence of the endemics and the vegetational affinity with the even more distant Falkland Islands (off Cape Horn), are all problems of lively plant-geographical interest to us as to Hooker. Problems of equal interest are those raised by the very marked changes of climate which have occurred in these now desolate latitudes in fairly recent geological time. Hooker himself was profoundly impressed by seeing not only coal but also fossilized tree trunks of considerable size (one is specifically mentioned by Ross as 7 ft. in circumference), although the existing vegetation cannot boast even a shrub, still less a tree, and this circumstance was certainly one of the more powerful reasons which predisposed him to the immediate acceptance of the idea of evolution when it came.

The fossil woods brought back by the Ross expedition were not further investigated until 1921, when Edwards[2] of the British Museum identified them as coniferous. Shortly after this in 1934 Seward and Conway[3] identified araucarian twigs and cone scales in some macroscopic plant remains brought back by de la Rue in 1931. This material also contained the remains of a moss and some indeterminate fragments of dicotyledonous leaves and ferns.

An additional contribution is now available in the eighth part of vol. 2 (pp. 129–142) of the Reports of the British, Australian and New Zealand Antarctic Research Expedition of 1929–31, published at Adelaide, 1947, under the title of "Plant Microfossils from the Lignites of the Kerguelen Archipelago by Isabel C. Cookson" (price 4*s.* 6*d.*). This is one of the few applications of the pollen analysis technique to fossil floras of the southern hemisphere, and though carried out on very limited material the results add greatly to previous knowledge while holding out considerable hope of more to come.

As was to be expected from Seward and Conway and from Edwards, araucarian pollen predominates. This is, however, not the only gymnosperm present. Five distinguishable species, undoubtedly belonging to the Podocarpaceæ though of less certain generic identity within that family, are listed under the form genera of *Disaccites* (*Podocarpidites*), *Polysaccites* (*Microcachryidites*) and *Disaccites* (*Phyllocladidites*). Angiospermous pollen is also present though more sparingly, five species only being so far recorded, three of which appear to be dicotyledons and two monocotyledons. In contrast there are ten varieties of Pteridophyte spores, probably of ferns, but not identifiable generically. There are likewise two species of ascomycetous fruit body.

While the available information does not yet permit of a generalized palæoecological statement to be made of this most interesting region it seems clear that gymnosperms and ferns predominate in the lignites so far examined, the age of which is on that account thought to be Tertiary. It is greatly to be hoped that this work will be further extended by a systematic study of additional collections and through the whole thickness of the deposits.

[1] Ross, J. C., "A Voyage of Discovery and Research in the Southern and Antarctic Regions during the Years 1839–43" (London, 1847).

[2] Edwards, W. N., *Ann. Bot.*, **35**, 609 (1921).

[3] Seward, A. C., and Conway, V., *Ann. Bot.*, **48**, 715 (1934).

BIOLOGY AND CONTROL OF THE PEA MOTH

THE pea moth, *Laspeyresia nigricana*, Steph., is a widely distributed pest of garden and field peas in Great Britain and central and southern Europe, while in North America it has spread to all main pea-growing areas. In England the most severe losses occur in the pea-producing counties of Lincoln, Essex and Kent. D. W. Wright and Q. A. Geering, of the Horticultural Research Station and School of Agriculture, Cambridge, have published a useful paper on the biology and control of the pea moth (*Bull. Entom. Res.*, **39**, pt. 1, 57; 1948).

It appears that the moths show no special preference for ovipositing on or near the flowers or pods. The larva feeds on the young seeds in the pod and bores a hole through the pod-wall for the purpose of reaching its food. The hole heals over, however, in a few days, leaving a small blister. When fully grown the larva spins a thin, web-like cocoon immediately below the soil surface, wherein pupation takes place. The majority of the moths emerge before the end of July in the following year. Normally there seems to be only a single generation of this insect in Britain.

The trials that were carried out indicate that different varieties of peas differ widely in their susceptibility to attack. Furthermore, the infestation on the varieties is influenced by the amount of foliage cover that is available, the heaviest attacks being where the cover is most dense. Certain varieties of peas are well known to escape much of the severity of pea moth attack if sown early. Also, it appears that crops can be grown almost free from infestation if sown in the latter half of June or in July, since they will mature after the flight period of the moth.

It is recommended that the residue of crops picked green should be removed immediately and fed to stock, made into manure or ensilaged. This prevents the caterpillars from maturing in the seeds and pupating in the soil. Experiments using D.D.T. as an emulsion, or as a suspension, showed that considerable reduction in attack could be obtained with the concentration at 0·5 per cent by weight of D.D.T. It was found that the spray should be applied before egg-hatching has begun which, for sowings made in late April and in May, would be about 7–10 days after the first flowers appear on the crop.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant Lecturer (with high mathematical qualifications) in the Department of Mathematics—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S.W.3 (August 28).

Histological Technician—Prof. A. Durward, Department of Anatomy, Medical School, The University, Leeds 2 (August 30).

Professors or Assistant Professors of Physics, Zoology, Botany, Mathematics, Geography, at the Higher Teachers' Training College, Baghdad; Professor or Assistant Professor of Mathematics, Assistant Professor of Physics, Professor of Biology, Lecturer or Assistant Professor of Psychology, Professor of Chemistry, at the Queen Alivah College; Dean, and a Professor of Electrical Engineering, at the College of Engineering; Assistant Professor of Economic Statistics, at the College of Commerce—The Cultural Attaché, Iraqi Embassy, 22 Queen's Gate, London, S.W.7 (August 31).

Assistant in Botany—The Secretary, The University, Aberdeen (August 31).

H.M. Inspectors of Factories—The Secretary, Ministry of Labour and National Service (O.E.11), 80 Pall Mall, London, S.W.1 (August 31).

Principal, a Professor of Civil Engineering, a Professor of Mechanical Engineering, and a Professor of Electrical Engineering, at the Government College of Engineering, Dacca—The High Commissioner for Pakistan, 14 Fitzhardinge Street, London, W.1 (August 31).

Senior Professional Officer (Ceramic and Refractory Research), University of the Witwatersrand, Johannesburg—The Director, Government Metallurgical Laboratory, c/o Mr. Victor Reid, South Africa House, Trafalgar Square, London, W.C.2 (August 31).

Chemist-in-Charge at the Royal Ordnance Factory, Pembrey, under the Ministry of Supply—The Ministry of Labour and National Service, Technical and Scientific Register, K Section, York House, Kingsway, London, W.C.2, quoting F.606/48A (August 31).

Chemists in certain Explosive Factories in the Directorate of Ordnance Factories under the Ministry of Supply—The Ministry of Labour and National Service, Technical and Scientific Register, K Section, York House, Kingsway, London, W.C.2, quoting F.605/48A (August 31).

Laboratory Assistant (Grade I) in the Department of Zoology—The Secretary, Bedford College for Women, Regent's Park ,London, N.W.1 (September 4).

Lecturer in Agriculture, a Lecturer in Dairying, an Assistant Lecturer in Botany, a Lecturer in Horticulture, and a Horticultural Adviser and Lecturer (junior post)—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow, C.2 (September 4).

Lecturer (Grade II or Grade III) in Electrical Engineering—The Secretary and Registrar, The University, Bristol (September 4).

Lecturer in Inorganic Chemistry—The Registrar, King's College, Newcastle-upon-Tyne (September 11).

Senior Organic Chemist in the biochemistry section for work on the organic constituents of fruit-bearing plants—The Secretary, East Malling Research Station, East Malling, Maidstone, Kent (September 11).

Head of the Instrument Division at the National Institute for Medical Research, Hampstead—The Secretary, Medical Research Council, 38 Old Queen Street, London, S.W.1 (September 11).

Assistant Lecturer, preferably with some experience in Radar research—The Registrar, University College, Hull (September 13).

Assistant Lecturers (2) in the Department of Civil Engineering—The Professor of Civil Engineering, Queen's University, Belfast (September 15).

Mullard Readership in Electronics at the Imperial College of Science and Technology—The Academic Registrar, University of London, Senate House, London, W.C.1 (September 15).

Professor of Power Stations in the Mechanical Engineering Department of the Faculty of Engineering, Farouk I University, Alexandria—The Director, Egyptian Education Bureau, 4 Chesterfield Gardens, London, W.1 (September 15).

Senior Lecturer in Electrical Engineering at the University of Melbourne—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (September 15).

Professor of Botany at Fouad I University, Cairo—The Director, Egyptian Education Bureau, 4 Chesterfield Gardens, London, W.1 (September 15).

Inspectors (Salmon and Freshwater Fisheries) in the Ministry of Agriculture and Fisheries—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 2258 (September 16).

Senior Experimental Officer in an experimental research establishment of the Ministry of Supply, near Salisbury—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2256 (September 17).

Research Fellowship in the Turner Dental School—The Registrar, The University, Manchester 13 (September 18).

Simon Visiting Professor, and Simon Research Fellowships, for Advanced Study or Research in the Social Sciences—The Registrar, The University, Manchester 13 (September 29).

Agricultural Economists (3, one at each College)—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow, C.2; The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh 8; The Secretary, North of Scotland College of Agriculture, 41½ Union Street, Aberdeen (September 30).

Lecturer (ungraded) in Veterinary Parasitology—The Registrar, Schools of Tropical Medicine and Veterinary Science, The University, Liverpool (September 30).

Assistant Examiners in the Patent Office under the Board of Trade—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 45A (September 30).

Chair of Mechanical Engineering, a Senior Lecturer in Zoology, a Lecturer in Zoology, and a Technician in the Department of Zoology, at Auckland University College, New Zealand—The Secretary, Universities Bureau of the British Empire, 8 Park Street, London, W.1 (October 1).

Readership in Civil Engineering at King's College—The Academic Registrar, University of London, Senate House, London, W.C.1 (October 1).

Chair of Organic Chemistry at the Imperial College of Science and Technology—The Academic Registrar, University of London, Senate House, London, W.C.1 (October 4).

Curator of the Auckland Zoological Park—The Office of the High Commissioner for New Zealand, 415 Strand, London, W.C.2 (Auckland, October 29).

Lecturer in Tropical Hygiene—The Dean, Liverpool School of Tropical Medicine, Pembroke Place, Liverpool 3, endorsed 'Lectureship in Tropical Hygiene' (October 31).

Fellowships and Scholarships for the advancement of Extraction Metallurgy—The Secretary, Nuffield Foundation, 12–13 Mecklenburgh Square, London, W.C.1 (November 1).

Demonstrator in Zoology—The Secretary-Registrar, Wye College, Wye, Kent.

Plant Physiologist to study the physiology of cocoa, with special reference to water, nutrient and light requirements, and Plant Breeders to undertake the selection and breeding of cocoa types and varieties and progeny trials, at the West African Cocoa Research Institute, Gold Coast—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

Scientific Officer to deal with administrative aspects of research—The National Coal Board, Establishments (General) Branch Hobart House, Grosvenor Place, London, S.W.1, quoting TT/68.

Graduate (or equivalent) as Assistant in Enquiry Laboratory dealing with works problems submitted by member firms—The Printing, Packaging and Allied Trades Research Association, Randall Road, Leatherhead, Surrey.

Honours Graduate for work on engineering applications of fluid mechanics—The British Hydromechanics Research Association, 79 Petty France, London, S.W.1.

Laboratory Assistant (Grade II) for hygiene and bacteriology department—The Secretary, King's College of Household and Social Science, Campden Hill Road, London, W.8.

Scientists with research and practical experience in (*a*) Coal Mining (Ref. TT/70), and (*b*) Coal Chemistry, analytical work, metallurgy or coal tar (Ref. TT/71)—The National Coal Board, Establishments (General) Branch, Hobart House, Grosvenor Place, London, S.W.1, quoting appropriate Ref. No.

Lecturer in Mathematics at the University of Otago, Dunedin—The High Commissioner for New Zealand, 415 Strand, London, W.C.2.

Chemist by the East African Industrial Management Board, Nairobi, Kenya—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.21789/3E.

Laboratory Technician (male) in the Department of Chemical Pathology—The Secretary, Medical School, Guy's Hospital, London Bridge, London, S.E.1.

Managing Chemist to take charge of the Metallurgical Development laboratories in the Department of Atomic Energy at Springfields Factory, Salwick, Preston, a Chemist-in-Charge (must have extensive metallurgical knowledge with experience in modern methods of metallurgical investigation), and Chemists to supervise experimental work related to the metallurgical development involved in the production of Atomic Energy—The Staff Section, Ministry of Supply, Department of Atomic Energy, Risley, Warrington, Lancs.

Lecturer in Civil Engineering, and a Lecturer in Mechanical Engineering—The Clerk to the Governing Body, Battersea Polytechnic, Battersea, London, S.W.11.

Assistant Director (Metallurgical Development) in the Department of Atomic Energy, Risley—The Staff Section, Ministry of Supply, Department of Atomic Energy, Risley, Warrington, Lancs.

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MEDICAL EDUCATION

MEDICAL education continues to be the subject of very lively discussion. In 1944 the Goodenough Committee issued its much-quoted report on the "Organisation of Medical Schools"[1]. A year ago an authoritative sequel appeared in the form of the General Medical Council's "Recommendations as to the Medical Curriculum"[2]. Newer and detailed proposals have now been published under the title "The Training of a Doctor" under the authorship of a Curriculum Committee that was set up in 1945 by the British Medical Association[3]. In the background, reaching far back over the years, are many other reports on the same subject. Before considering where the British Medical Association's proposals stand in relation to those of the Goodenough Committee and the General Medical Council, it is useful to consider for a moment why the medical curriculum is always under fire. For so it would seem to be if one compares medical with other university departments; there has certainly been no corresponding wealth of reports about the teaching of chemistry, physics or electrical engineering.

The underlying reason would seem to emerge from the fact that the medical sciences, which are part of the general field of biology, have not evolved very far in the hierarchy of science. The physical sciences are well to the fore, and in their present state of development conform far more closely to the pattern that is expected of a well-knit and properly based structure of scientific knowledge. This in turn allows a clear academic separation between the fundamental sciences of physics and chemistry and such applied subjects as mechanical and chemical engineering. Corresponding divisions of interest are quite impracticable on the biological side. As a result, to take an example, the student of zoology or of agriculture may find himself equally concerned either with fundamental or applied science. The same dual, and at times confused, purpose besets the medical departments of a university. Thus, the overwhelming task of a medical school is to train practising doctors. Its next task, but a task not second in importance, is the training of medical scientists and the advancement of medical knowledge. It is this division of purpose which is clearly the background for all educational difficulties in medicine.

Because the two objectives of a medical school are pursued in the same harness, the curriculum for 'applied medicine', if it can so be called, is always immediately affected by changes in fundamental medical knowledge. Unfortunately, however, the curriculum has never been automatically readjusted so that proper weight is given to new advances in relation to old-established knowledge. What has generally happened is that new subjects, as they grew in importance, have been added to the existing syllabus, the structure of which has thus been altered not by changes in its general configuration, but mainly by the process of discrete accretion. Not surprisingly, the medical course has in consequence increased over the past thirty years or so from four to six years. If the same process were to continue, and the strong claims of new interests were admitted, there is no saying how many years would have to be allowed for the training of a doctor in twenty years time.

Here lies the main driving force behind the constant stream of discussions about the reform of the medical curriculum. There is a second to which the British Medical Association Curriculum Committee directs attention—namely, that advances in medical knowledge over the past fifty years have not resulted in a "proportionate improvement" in the standard of medical practice. It is almost a truism that the practice of medicine is more up to date in relation to new biological knowledge than are most industrial and engineering undertakings in relation to advances in the physical sciences. But this is obviously no reason for complacency, and the British Medical Association is right in insisting that, without improvements in the system of education, little can be expected in the quality of our medical graduates. Allowing for the fact that the bulk of the sixty thousand medical men in Britain are in one or other kind of practice, and therefore circumscribed in the expenditure of their energies, it is a startling fact that over the past fifty years or so, most major and fundamental advances in medical science have come from the few hundreds who have kept to the research laboratory. This is all too painfully obvious when one scans the list of Nobel laureates in medicine, or lists of medically qualified men who have been elected to the Royal Society—or to corresponding bodies in other countries. One cannot suppose that more than a fraction of the best minds among medical graduates have dedicated themselves to the laboratory. It is tragic, therefore, to contemplate how circumstances and education have limited the potentialities for advancing medical knowledge which actual practice provides.

In the remedies it suggests, the British Medical Association is at one with the Goodenough Committee and the General Medical Council about such things as the need to eliminate unnecessary detail and specialities from the curriculum; about the desirability of 'integrating' its various parts; and about the fact that the time is ripe to introduce into the curriculum such subjects as psychology and social medicine. It takes an independent line about many matters of more detailed policy. For example, it opposes the Goodenough recommendation that chemistry, physics and general biology for intending medical students could be taught in schools; it holds that anatomy and physiology could be confined to four instead of the five terms recommended in previous reports—although in this recommendation, since its proposed terms are longer, all that is suggested is the curtailment of vacations; it disagrees with the Goodenough Committee that, in general, one can combine good teaching and research abilities in the same individual, and suggests that where the head of a department is a research man, someone else should be made responsible for the teaching.

These and other like matters are, however, questions of detail. The real point is whether the British Medical Association's proposals regarding the direction and integration of the curriculum will achieve the "aim of the medical curriculum". The report takes the line that "the undergraduate medical course should be primarily concerned with the training in those basic principles of medicine which are a necessary foundation for all forms of medical practice". This in turn implies that the student should be trained over the whole field of medicine. "There should be no clash in outlook", the report reads, "between the practitioner and the research worker", since both use the same intellectual methods. And the British Medical Association Committee holds that a proper medical education would have the effect that the medical practitioner would continue to be a student throughout his postgraduate career.

Specialization in education is repeatedly attacked, and the report pleads for what is described as the "synoptic view". It argues for a "liberal and general" school education for intending medical students, and opposes early "vocational" concentration on science; "general culture", it states, should take the place of "premature narrow specialization in the basic sciences". In its insistence on the need for 'integration', it points out that the many subjects which come into the medical curriculum break the continuity of the student's career. For example, physics, chemistry, and biology should be taught in the first year of the medical course "as different aspects of general science". From this would emerge an understanding of the general principles of scientific method, which would be further laid bare in the syllabuses for anatomy and physiology. Continuity would be better assured by such measures as distributing the teaching of pathology and psychiatry throughout the clinical years, and integration would be helped by ceasing to break up the final examinations into the separate disciplines of surgery, medicine, gynæcology, and so on. The emphasis throughout the report is on re-ordering the curriculum to the end that the patient be seen as a whole. General medicine, the Curriculum Committee claims, is the 'linchpin' of the clinical subjects, and should be taught as the basic clinical subject from which the specialities have branched. "It must remain an integral study of human disease in all its facets, both physical and mental."

A number of these proposals are undoubtedly very sound. But on the other hand, the value of the report is not strengthened by obscure concepts, and in particular by what seems to be an undue allegiance to words such as 'unity', 'whole', 'fundamental principles' and 'general culture'. A synoptic view is clearly useful; but its over-emphasis seems to detract from rather than to enhance its importance. Man, we are told, must be regarded as a whole, and not as the sum of his component systems; "the sense of the unity of medicine is the special purpose of the teaching of general medicine". Instead of emphasizing excessive morphological detail, "the general truths of anatomy" should be inculcated. Students, we are also told, "must not be allowed to think that laboratory investigations are a substitute for personal observation. They should be trained to understand that the purpose of X-rays, pathological reports, and the like, is to refute or confirm the practitioner's own findings, and that they must be regarded as servants, not as masters."

It is difficult to avoid feeling that these are mostly platitudes. It is undoubtedly true that a man with a general education is often more interesting and intellectually alert than one without. But as a class, are doctors any less 'cultured' than, say, an equivalent number of men who did not concentrate on science in school and the university ? It is obvious also that a doctor should regard his patient as a whole, and "not as a collection of systems and organs corresponding to the specialities of medicine". But when a patient comes to a doctor, is he really regarded as such ? It is perfectly true, too, that a man should not become the victim of the techniques of observation which he uses. But equally, is it correct to imply that pathological studies or X-ray methods are not just another form of personal observation ?

Above all, it is dangerous to obscure the fact, which is what the Report does, that advances in medical knowledge have come about almost entirely out of increasing specialization, and through the fragmentation of the 'oneness' of medicine. The 'general physician' may be a disappearing species, but it has disappeared over a period in which the health of the people has been progressively improving.

How a deliberate avoidance of educational specialization, beginning at school and continuing through to the end of the 'intern' year spent after medical qualification, can materially improve the quality of medical practice is, therefore, difficult to see. More, not less, specialized scientific training would seem to be wanted if full advantage is to be taken in practice of advances in fundamental medical science. One wonders, therefore, whether the British Medical Association is not attempting the impossible, in so far as the verbal character it imposes on medical education is out of keeping with the trend of developments in medical practice. More and more the general practitioner is taking on the function of a sorting-machine which directs those sick whom it cannot help into specialized avenues for particular treatments. This fact the British Medical Association report clearly recognizes ; but nevertheless it consistently seems to write down the importance of the specialities. The trend cannot be condemned because specialization can be carried too far. That danger will be there whatever form medical education takes. Nor can the trend be stopped, for the simple reason that advances in knowledge, not only in medicine but also in every other field of science or applied science, inevitably mean greater and greater specialization.

If medical education is to undergo the fundamental overhaul which the British Medical Association Committee rightly describes as necessary, it is surely essential to safeguard the education of the specialist, and the specialist approach, as well as that of the general practitioner. The problem is whether the two aims can be satisfied by the same curriculum. The period of medical training is already very long in relation to the years of a doctor's service, and if several more years have to be added to a general medical curriculum for gaining experience in a speciality, the burden of education becomes almost too great. Sooner or later the question will have to be faced whether the approach to reform should not be the opposite of that advocated in most recent reports, including that of the British Medical Association Committee. What may be wanted is the division of the curriculum into specialized 'sectors' that cut right through the clinical and pre-clinical subjects. In such a vertical organisation, the cardiovascular 'sector' or 'department', or the neurological 'department', or the infectious diseases 'department', would embrace their relevant anatomical, physiological, pathological and clinical aspects. The medical student, after an initial year or so in which he became familiar with the language of the subject, and, in general terms, the layout of the body and the nature of its mechanisms, as well as the broad character of the most frequently used techniques of medical education and practice, could move from sector to sector, becoming educated in all aspects of each in the integrated way demanded by the British Medical Association Committee. Teachers would be sufficiently experienced to indicate the interrelations of different sectors, and so to impress the 'wholeness' of medicine in its most useful sense. The time spent in different sectors, and the emphasis of instruction in each, would be varied according to the needs of general practice. But no more time would be spent in all than would be deemed necessary to train a man for the declared purposes of general practice. After his first qualification, the would-be specialist would then concentrate in the sector or sectors of his interest, in an atmosphere where basic science and applied knowledge form an interrelated pattern, and in which either one or the other could become the central interest. A synoptic view over the whole field of medicine seems impossible to attain. A synoptic view within a sector of, say, the problems of digestion and nutrition—all the way from their anatomical to their biochemical aspects—or of the locomotor system, is far more within the bounds of educational possibility. In short, horizontal may have to give way to vertical integration if the medical curriculum is to be materially improved. At the moment the preclinical subjects of anatomy, physiology, and biochemistry supply the normal picture of the whole field that is later split up into the variety of specialities that make up clinical medicine. No amount of horizontal integration or of reference back during the clinical years to the preclinical subjects is likely to achieve as useful an interrelated pattern of education as would a vertical division of interests.

It is in these major matters that the British Medical Association report is least convincing. On the other hand, it contains many useful suggestions that could be immediately applied in medical schools, to the betterment of present educational methods. Very useful, too, is its suggestion that there be formed an "Association of Teachers in Medical Schools" to discuss alternative possibilities for the curriculum—for the British Medical Association Committee has wisely recognized that all proposals are in the nature of plans for experimental action, and that plans must necessarily change with the changing content of medicine itself.

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[1] Report of the Interdepartmental Committee on Medical Schools. (H.M. Stationery Office, 1944.) (Reviewed in *Nature*, **154**, 322; 1944.)

[2] Recommendations as to the Medical Curriculum. General Medical Council, April 1947. (Reviewed in *Nature*, **160**, 481; 1947.)

[3] The Training of a Doctor. Report of the Medical Curriculum Committee of the British Medical Association. (London, Butterworth and Co., Ltd., 1948.) 7*s.* 6*d.* net.

FERN PHYLOGENY

Genera Filicum

The Genera of Ferns. By Dr. Edwin Bingham Copeland. (Annales Cryptogamici et Phytopathologici, Vol. 5.) Pp. xvi + 247 + 10 plates. (Waltham, Mass.: Chronica Botanica Co.; London: Wm. Dawson and Sons, Ltd., 1947.) 6 dollars.

A Revised Classification of Leptosporangiate Ferns

By E. E. Holttum, *J. Linn. Soc. London*, **53**, pp. 123–158 (1947).

BY a curious coincidence two independently compiled reclassifications of the ferns have appeared in print almost simultaneously but from different parts of the world. Both are of very considerable botanical interest, since the phylogeny of ferns is a topic of wider evolutionary significance than the taxonomic context alone might suggest. The phyletic views of the late Prof. F. O. Bower, based largely on anatomical and developmental data, are well known to all morphologists and have for long been the basis of teaching in many universities. The phyletic views of the pure systematist in pteridology have, however, been only imperfectly available. Christensen's phyletic scheme published in 1938 was regarded by its author as only tentative, though unfortunately he did not live to develop it more fully. This scheme has, however, been kept vividly in mind by both the authors under review and both can, in a sense, be read as commentaries on Christensen as on Bower.

The circumstances of composition of the two works are very different. Holttum's explanation of his own is that it was a sequel to the compilation of a Fern Flora of the Malay Peninsula which had been carried out at Singapore between 1942 and 1944, that is, during the Japanese occupation. The step from this to a reclassification of the leptosporangiate ferns seems, therefore, to have been in a sense unpremeditated and the outcome of close acquaintance with the very rich fern vegetation of that country. By being confined to a limited section of the ferns the ground covered is that contained in vol. 3 of Bower's classic work, all of which was, until quite recently, included in the spacious but unnatural family, the Polypodiaceæ.

In Holttum's view the Polypodiaceæ *sens. lat.* should be replaced by five families, namely, Polypodiaceæ *sens. strict.* (including *Polypodium* and *Dipteris*), Grammitidaceæ, Thelypteridaceæ, Dennstædtiaceæ and Adiantaceæ.

To a British botanist the chief interest of these innovations is likely to lie in the third and fourth families. By placing the male fern (*Dryopteris Filix-mas*) as a derivative of *Dennstædtia*, Holttum departs from, and perhaps undermines, one of the central tenets of Bower's phylogeny by which the Dryopteroids are thought to derive from an ancestor with superficial but not marginal sori. Further, by separating the marsh fern (*Thelypteris*) not merely into a different genus from the male fern but also into a different family, the Thelypteridaceæ, Holttum endorses and extends a long-considered view of Christensen's that the genus *Dryopteris sens. lat.* is polyphyletic. With this latter view, it may be said in passing, some recent cytological work of the reviewer is in complete agreement. An independent statement of somewhat similar views had previously been published by Ching[1], though this could not have been known to Holttum at the time.

Copeland's book is a work of greater scope, since it sums up the views of a life-time primarily devoted to the study of ferns and is intended as an authoritative work of reference, an intention which is on the whole excellently fulfilled. It includes the whole of the ferns and is preceded by a few pages of highly instructive historical introduction in which the taxonomic views and practice of the author are briefly discussed. Of the 305 genera recognized and described, only six have not been personally accessible to him, while 33 have been created by him and 69 others revived. Some familiar genera have, on the other hand, been suppressed, and a British botanist will perhaps be surprised to note the submergence of, for example, *Scolopendrium* in *Asplenium*. The treatment of the Polypodiaceæ (which is split into twelve families) differs in many ways from that of Holttum—a divergence which is easily understandable in the light of Copeland's introduction; but both authors endorse the views of Christensen in his treatment of *Dryopteris* and in other ways. Of the new or revived genera a large proportion occur in the Hymenophyllaceæ, the 600-odd species of which are distributed into thirty-three genera instead of the two unwieldy groups of *Trichomanes* and *Hymenophyllum*. Pedantic as this may at first appear it is clearly an essential preliminary to the attainment of clarity on phyletic trends within this large and interesting group.

The weakest part of the book is the treatment of anatomy. This is clearly not the centre of the author's interest, though he is compelled to make some use of it in his treatment of the Polypodiaceæ. It is perhaps scarcely his fault that comparisons with Bower will be more consciously made by some of his readers than they may have been by himself; but the extreme compression of the allusions to anatomy makes their inclusion of doubtful value in certain cases. The very well known and complex stem structure of the bracken (*Pteridium*), for example, is merely referred to as a solenostele without further qualification—a degree of simplification which amounts almost to distortion.

On the positive side, a point of unusual interest to a northern reader is the stress which is laid on the southern hemisphere as the putative place of origin for a large proportion of existing fern genera. This view had been strongly impressed on the author by his earlier studies of the Hymenophyllaceæ and other groups, which still have a predominantly southern distribution, and also by his long residence in the Philippines and familiarity with their flora. According to Copeland nine-tenths of all tropical fern genera are of southern origin, and that the Antarctic continent itself may have been the centre of this evolutionary development is an idea which is less familiar to northern botanists than its importance deserves. For this reason alone the book deserves close and critical study by students of vegetation as well as by students of ferns. It should also perhaps be mentioned that the potential value to pollen analysts of the numerous descriptions of fern spores has already been pointed out by Erdtman in a Swedish review; the absence of illustrations may, however, perhaps prove a disadvantage here.

Though it is always possible, in a compilation of this kind, to make suggestions of detailed improvements, these should not, in this case, be regarded as seriously detracting from the sterling value of this book, which as a taxonomic study will remain an indispensable source of reference for many years. Not only the author, but also the publishers are to be congratulated on the production of a compact, convenient, and scholarly piece of work.

I. MANTON

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[1] Ching, C., "Natural Classification of the family Polypodiaceæ", *Sunyatsenia*, 5, pp. 201–267 (1940).

PATHOLOGY OF TUMOURS

Pathology of Tumours

By Prof. R. A. Willis. Pp. xxiii + 992 + 52. (London: Butterworth and Co. (Publishers), Ltd., 1948.) 63*s.* net.

IN all branches of biology where the experimental method, and the co-operation of the chemist and the physicist, are extending our knowledge of living things, it is still essential for the results of morphological inquiry not only to be preserved but also to be reviewed, summarized and restated in the light of contemporary opinions. The descriptive morphologist acquires his knowledge and judgment by long experience, which no interloper, however gifted with modern techniques, can hope to achieve in a short space of time as a subsidiary interest. This is particularly the case with microscopical work, where sound interpretation of the visual image usually requires long experience and training.

Nevertheless, the chemist and physicist who are partners in a modern biological research team will seek at least some acquaintance with the morphological side of the problems they are investigating, and here is a book on tumours which not only pathologists but also all workers in cancer research will find extremely valuable. The author has not provided just another detailed work of reference, confined to the systematic description of the structure of tumours. He begins with an admirable summary, extending over twelve chapters, of the main characteristics of tumour formation, their mode of origin, statistical study of incidence, experimental production in animals, metastases, and the theories of the nature of neoplasia. The second part of the book describes with commendable precision the characteristic features of tumours in specific regions of the human body and includes many case-histories, together with information on comparable tumours in animals.

It is now generally accepted that the successful production of an advanced text-book should be the work of collaborators each responsible for some particular section. So many text-books by a single author are apt to become reproductions in condensed form of the existing literature, enlightened only in those sections where the author has detailed experience. Dr. Willis makes it quite clear that, though he wishes to give a general outline, much of the book is a personal record of his own observations and conclusions. The five hundred illustrations are all from material he has studied personally. Inevitably there are controversies concerning the interpretation of some types of tumour. Where conflict arises with other pathologists, it is refreshing to find the author stating his convictions, avoiding 'non-committal vagueness' and at the same time admitting that his own opinions may have to be modified in the light of further research. There is a vigour and a challenging frankness in his criticism of the work and opinions of others which is perhaps characteristic of the Australian temperament. Where controversies have been tediously prolonged, the more heretical contributors are singled out as "pathologically incorrigible, absurd or deservedly moribund"—expressions which English authors of scientific books and papers unfortunately go out of their way to avoid. The author's opinions, though forcibly stated, are given, however, with reasons that can only be helpful in allowing the reader to distinguish reasonable hypothesis from dogmatic assumption.

As a work of reference the book is well constructed with clear headings to the numerous sub-sections of each chapter. In the references the more important papers are distinguished by a full title with the author's name in block capitals, while the less important papers are indicated in smaller type without title. Dr. Willis wrote this book while holding the Sir William H. Collins chair of comparative pathology in the Royal College of Surgeons of England. He is now director of the Department of Pathology of the Royal Cancer Hospital, London.

E. S. HORNING

FORCES BETWEEN COLLOIDAL PARTICLES

Theory of the Stability of Lyophobic Colloids

The Interaction of Sol Particles having an Electric Double Layer. By E. J. W. Verwey and J. Th. G. Overbeek, with the collaboration of K. van Nes. Pp. xi + 205. (New York and Amsterdam: Elsevier Publishing Co., Inc.; London: Cleaver-Hume Press, Ltd., 1948.) 22*s.* 6*d.* net.

MANY of the classical investigations of colloidal chemistry were concerned with the stability of colloidal solutions of insoluble substances, such as gold, arsenic sulphide, silver halides, etc. The well-known phenomenon of coagulation of these sols by comparatively small concentrations of electrolytes suggested that their stability was connected with their electric charges. A considerable amount of research has been made in the past to discover the magnitude and origin of the electric charge on the particles and the nature of the electrical double layer which exists around them in salt solutions. Although qualitative and semi-quantitative explanations have been given of the phenomenon of coagulation and of the rule of Hardy and Schulze, according to which the ionic concentration required for precipitation diminishes rapidly with the charge of the effective ion, yet a complete and satisfactory theory was still lacking.

The present volume contains the results of theoretical investigations on the problem which were carried out by the authors in the Netherlands during the war years. Some short and incomplete accounts of this work have appeared in various journals, but many of the details are published here for the first time. The book, therefore, has the character of a research monograph. It undoubtedly takes the problem to a more definitive stage and will be studied with care by all who are interested in electrical double layers and with the colloidal state. The publishers are to be commended for making the work available to the English-speaking world in such a complete form.

Briefly, the authors' object was to examine in detail the potential curves for the interaction of particles which are obtained by combining the repulsion which arises from the interaction of their double layers with the London – van der Waals' attraction. Following preliminary work by J. H. de Boer and H. C. Hamaker, it is found that a fairly complete explanation of the coagulation process is obtained from the consideration of the combination of these two types of interaction, using reasonable values of the London attractive constant.

For many readers the most interesting part of the book will be the discussion of long-range attractive forces between particles, which are large compared with atomic dimensions. It is found by summation between all the atoms that the van der Waals' attraction diminishes comparatively slowly over distances comparable with the particle size. As this would give rise to appreciable forces between large particles, a relativity correction is suggested to the London expression, which has the effect of reducing to zero the van der Waals' forces at distances of more than about 10^{-6} cm.

One consequence of the slow decline of the van der Waals' attraction within this range is the fact that at the greater distances the attractive forces may again exceed the repulsive, giving a shallow minimum in the potential energy curves at distances of the order of 10^{-6} cm. It is suggested that this may produce thixotropy with non-spherical particles and may be responsible for the curious phenomenon observed by Bernal and Fankuchen with tobacco mosaic virus, namely, the concentrated aqueous phase in which the rod-shaped protein molecules are arranged in alignment at distances varying from zero to 300 A. or more.

J. A. V. Butler

CORROSION OF METALS

An Introduction to Metallic Corrosion

By Dr. Ulick R. Evans. Pp. xxxvi + 211. (London: Edward Arnold and Co., 1948.) 12*s.* 6*d.* net.

The author's object in writing this book was, in his own words, "to provide an account of Corrosion short enough to be read from start to finish within a reasonable time". Let it be said at once that he has succeeded in his purpose and succeeded admirably. This "Introduction to Metallic Corrosion" provides a general, authoritative and up-to-date survey of the subject, which the serious student should be able to master in the course of a few weeks.

The format and general lay-out of the book resemble that of Dr. Evans' "Metallic Corrosion, Passivity and Protection", but the text is much shorter, amounting roughly to one quarter of that of the major work. This compression has been achieved by the elimination of a considerable amount of less important detail and the rearrangement of the subject-matter in eight chapters as compared with fourteen. The chapter headings provide an apt summary of the contents and illustrate the simple logical classification adopted by the author: they are: film growth; electrochemical corrosion; corrosion by acids and alkalis; influence of environment; effect of stress, strain and structure; prevention of corrosion by soluble inhibitors; prevention of corrosion by protective coverings; and statistical and mathematical treatment. The same methodical arrangement is followed in the sub-headings. For example, those for Chapter 6, "Prevention of Corrosion by Soluble Inhibitors", are: principles of inhibition; cathodic inhibitors; anodic inhibitors; inhibitive water treatment in industry; pickling processes to remove scale and rust; inhibitive pretreatment.

All this renders the book easy to read and to follow. It will also be evident from these headings that, while Dr. Evans dwells with unequalled authority on the whole range of corrosion theory, he is at pains to deal with the practical aspects of the problem and to render the utmost assistance to those who have to grapple with corrosion in the rough and tumble of industry.

One attractive and likable feature of the book is that references to the literature are reduced to a minimum; even so, 165 are needed. These are segregated at the end instead of being given as footnotes. Too much attention can never be paid in any scientific text-book to details such as this, which, however unimportant in themselves, in the aggregate make all the difference between a readable and a tedious book. As an eminent psychologist has written, "It requires considerable effort even to follow one's inclinations with consistency", and any aids such as this to lighten the burden of study are not to be despised.

The book is prefaced by an excellent historical introduction. In this, Dr. Evans covers attractively, in the short compass of some five thousand words, the development of knowledge of the subject from the dawn of history to the present day. Some of the theories, held even by research workers who are still alive, make rather queer reading now; but the general impression gained from Dr. Evans' survey is that of constant progress resulting from the integration and interplay of the ideas of a large number of earnest seekers after truth. Not all of them have been cast in an academic mould, for as Dr. Evans remarks: "Industrial necessity has led to the investigation of many points which the pure scientist would probably have overlooked".

He gives an example to illustrate this. An even better one might be that intuitive reasoning alone could scarcely disclose that the initial cause of the corrosion of steel railway sleepers is damage to the protective tar coating caused by the hob-nailed boots of the men walking up and down the line!

The only feature of the book about which a little diffidence might be expressed is the final chapter on statistical and mathematical treatment. It might have been better to omit this. Statistics is a highly specialized subject, to which Dr. Evans has made important contributions, and it is no aspersion on the mental calibre of many who read this book to suggest that they will find this chapter difficult. Dr. Evans has evidently considered this point and was, no doubt, influenced in his decision by the fact that the subject-matter had not previously been published as a connected whole.

In brief, this is an attractive, well-written and well-produced book which will fulfil the purpose for which it is intended, and will undoubtedly appeal to a much wider circle of readers than the more comprehensive "Metallic Corrosion, Passivity and Protection". It is fully worthy of the author's high reputation.

J. C. Hudson

THE ATOMIC ENERGY RESEARCH ESTABLISHMENT, HARWELL

THE Atomic Energy Research Establishment was founded by a decision of the Government in November, 1945, and Prof. J. D. (now Sir John) Cockcroft was appointed director in January, 1946. In order to provide a nucleus of accommodation and a prepared site, the permanent R.A.F. aerodrome of Harwell was allocated to the Establishment and building work began there in April, 1946. Harwell was chosen because of its convenient geographical location, combining reasonable access to London with nearness to a large university (Oxford), which was considered to be important so that staff should have good opportunities for discussion with university colleagues.

A nucleus of experienced staff was available in 1946, some of whom had worked in the United States Atomic Energy Project at Los Alamos and Berkeley, while others had helped to build the Atomic Energy Plant at Chalk River in Canada. These were joined by experimental electronics staff working at the Telecommunications Research Establishment in Malvern, and by a few senior members of universities. This nucleus has been added to by the recruitment of junior staff, and there are at present Divisions of Theoretical Physics, Nuclear Physics, General Physics, Chemistry, Chemical Engineering, Metallurgy, and Health, each of the size of a large university research school.

The Establishment has very close links with the universities and industry. Many senior members of the project after the War returned to take charge of university departments; these scientific workers are now consultants to Harwell and some of them serve on the Technical Committee which advises the Department of Atomic Energy. In addition, many of the technological problems of the Establishment are solved by collaboration with industry and with laboratories of Government departments and research associations.

The purpose of the Establishment is to carry out fundamental research and development in atomic energy. It is responsible also for providing scientific and technical information to the Controller of Production, Atomic Energy (Lord Portal) and his engineering organisation at Risley, which is preparing the design for the plutonium production plant which is being built near Sellafield in Cumberland.

Pile Programme

The first requirement for an atomic energy programme of this nature was to build piles, and the first pile, GLEEP (graphite low energy experimental pile), was completed in August, 1947. It is a slow neutron graphite moderated reactor developing 100 kW. of nuclear energy. The simplest possible design was chosen so that early experience could be gained in pile operation, and, in fact, the time taken from beginning constructional work to the start-up of the pile was only just over a year.

It has a concrete shield, five feet thick, and the graphite blocks and natural uranium rods are built up within the shield roughly in the form of a cylinder lying on its side. The power-level at which the pile is operating is measured by means of boron trifluoride chambers sunk into the pile, and the current in the chambers suitably amplified is displayed in the control room on a dial calibrated directly in kilowatts. This information is also used to maintain the power of the pile at a constant level by controlling the position of neutron-absorbing cadmium 'control rods', hanging vertically in the pile. A second set of 'shut-off rods' is available to shut down the pile.

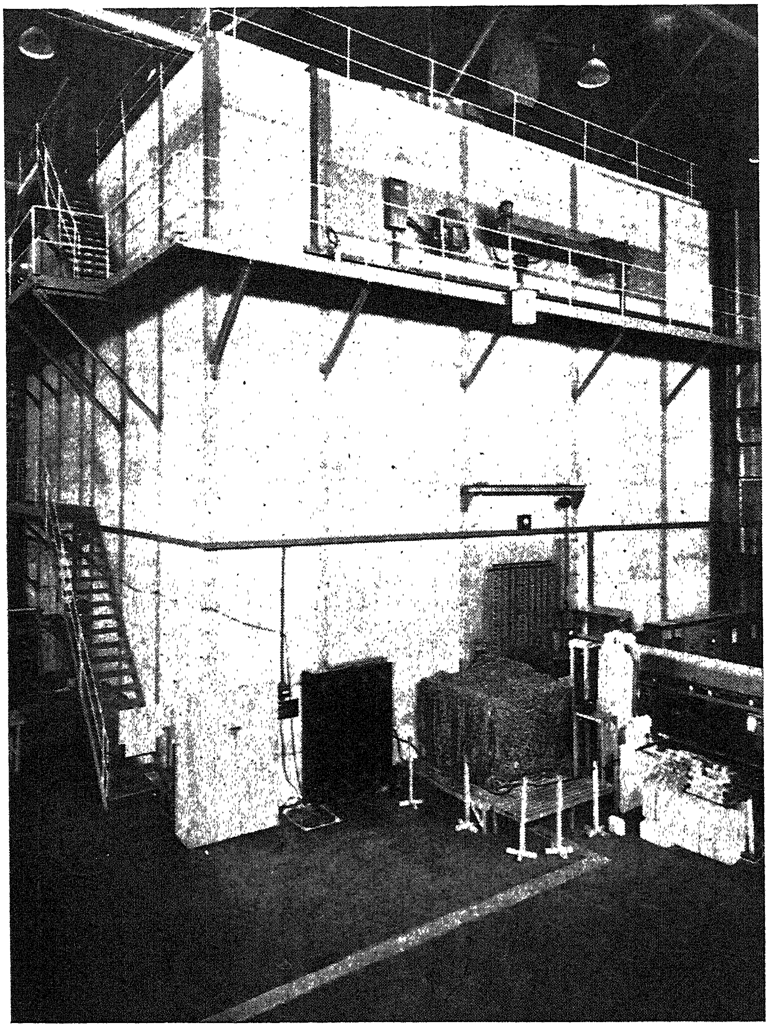
GLEEP is being used for measurement of the properties of atomic nuclei, for testing the nuclear properties of materials used in the construction of piles and for the production of radioactive isotopes.

The second pile, BEPO (British experimental pile), started up at 3 p.m. on July 3, 1948. Although not much larger physically than GLEEP, it is a much more complicated engineering structure and is designed to develop 6,000 kW. of nuclear energy. The heat is removed by an airstream which is drawn through the channels in which the uranium rods lie, and exhausted through a 200-ft. chimney stack. This pile will be used for studying the effects of irradiation on the structural and physical properties of materials which will be used in future piles, and the much higher neutron flux available makes possible a correspondingly wider range of experiments than in GLEEP. BEPO will also be the main source of radioactive isotopes for Great Britain, and it is expected that this work will be transferred from GLEEP to BEPO towards the end of this year, thus freeing GLEEP for full-time experimental work.

In preparation for building these two piles, it has been necessary to develop the production of pure graphite both in Canada and in Great Britain, and also to produce pure uranium metal and fabricate from it the aluminium-encased uranium rods which are used in the piles. This work has involved a large development programme, all of which has been undertaken outside the Establishment, both by industry and other Government establishments.

After the operation of piles, the next stage in a pile programme is the extraction of plutonium from the irradiated uranium metal, and information on the extraction process will be required for the Sellafield plant. The chemical problems involved in the separation of plutonium from the unused uranium and the highly radioactive fission products are among the most difficult in the atomic energy programme, and for this and other radiochemical work a new laboratory is being built at Harwell. This new radiochemical laboratory is a large two-story building, consisting of a central administrative block, connected by air locks and changing rooms to two wings. The wings contain a number of self-contained laboratory suites, each fitted with lead-lined chambers where all radioactive work will be done. A very large air flow is required through the chambers, equivalent at maximum rate to 120 air changes per minute in the laboratories, and this has led to the provision of an exceptionally large ventilation system, the air ducts for which, together with other services, occupy the whole upper floor of the building. Until this building is complete, temporary laboratories for the work have been provided in one of the original buildings.

Buildings are also being erected for chemical engineers, who will follow up the work of the research chemists with semi-scale plant. The chemical engineering programme includes the study of methods of extraction of uranium from the many kinds of low-grade ores in which it occurs.



General view of GLEEP

will stand high temperatures and be suitable for use in pile construction. Third, the chemical extraction problem must be solved—the fissile material produced must be separated economically from the unused uranium or thorium and the intensely radioactive fission products. Fourth, a method of disposal must be found for the large amount of unwanted radioactive material which would be produced by power stations operating on nuclear fuel.

These problems are difficult, and their solution is going to take time. For this reason, no serious person working in the field believes that nuclear energy will make any contribution to world power during the next decade. At present, work is entirely in the theoretical and laboratory stages; but it is probable that a number of pilot plants will be built to allow all these problems to be investigated. Until this is done no accurate assessment of the possibilities for the future can be made.

Industrial Applications of Nuclear Power

The Atomic Energy Research Establishment is working on the problem of the application of nuclear power to industrial purposes. A very small beginning will be to extract from the cooling air stream some of the heat developed by BEPO and to use it for space heating. A heat exchanger for this purpose is being installed.

The design of natural uranium piles in which power could be generated as a by-product at a moderate efficiency is being investigated in detail. This investigation is not complete; but it would appear that the construction of such piles is likely to be technically feasible. They would not, however, be worth while economically since such piles only burn up a very small proportion of the uranium. They would only be worth while as a first step to gain experience.

If nuclear power is to become important in the world, four major problems have to be solved. First, the so-called breeding problem must be solved—uranium 235, the only naturally occurring, or 'primary', nuclear fuel must be made to breed 'secondary' fuel from more abundant materials: either plutonium from uranium 238 or U233 from thorium. Second, materials must be found which

Nuclear Physics

For fundamental research in nuclear physics the Establishment is being equipped, in addition to the two piles, with several particle-accelerating machines.

A frequency-modulated cyclotron with 110-in. diameter pole pieces is under construction which will produce particles with a maximum energy of about 200 MeV.: it will be completed about the end of this year. This machine will enable the nuclei of most atoms to be broken up, and will be used to produce new types of nuclei which cannot be produced in the piles.

For the production of monokinetic beams of lower-energy particles, a 5-million volt Van de Graaff generator has been built. The design is similar to that of a machine recently completed by Prof. Van de Graaff at the Massachusetts Institute of Technology, and close contact has been maintained between the Atomic Energy Research Establishment and the Massachusetts Institute of Technology teams. The design voltage has been obtained without the accelerating tube in position, and tests are in progress with accelerating tubes. A 2-MV. machine for work in radiation chemistry has been built and is being tested by the manufacturer.

In addition to machines for work at Harwell, the Establishment is assisting universities and the Medical Research Council by carrying out, on behalf of the Department of Scientific and Industrial Research, development of high-energy particle accelerators for use in universities and medical departments. A group working at the Telecommunications Research Establishment in Malvern is directing the development of synchrotrons, including two 30-MeV. machines for the Medical Research Council, a 140-MeV. machine for the University of Oxford and a 300-MeV. machine for the University of Glasgow. It is also developing the design of linear accelerators and recently completed a 4-MeV. machine which is now in great demand for experimental work in nuclear physics and radiation chemistry.

Apart from accelerating machines, a beta spectrometer has been completed with provision for automatic recording, and small groups are working on the design of neutron spectrometers and other problems.

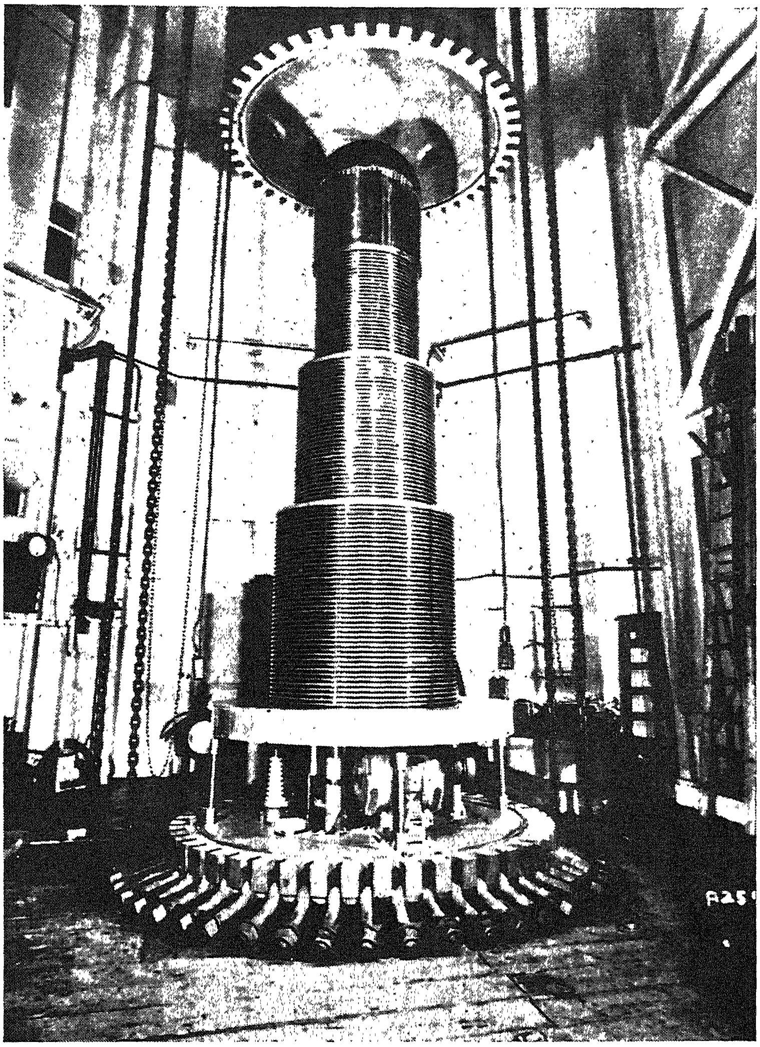
The Isotope Programme

It has already been announced that GLEEP has been used for the production of radioactive isotopes since September 1947. The rate of production of samples has increased steadily and is now about 150 per month. Altogether more than eight hundred deliveries have been made, mostly to English universities and hospitals and to workers at the Establishment, but including a few to European countries, and one air delivery to South Africa.

It is expected that BEPO will take over the production of radio-isotopes towards the end of 1948. It will then be the main source of radio-isotopes for Great Britain, and will make it possible to extend the supply to countries in the British Commonwealth and Europe. The higher neutron flux available will allow the preparation of a much wider range of materials, and of higher activity samples.

It is intended that the chemical processing and delivery of samples, except those with very short half-lives, will be undertaken by the Radio-Chemical Centre at Amersham, and arrangements have been made for the Chemical Research Laboratory to prepare complicated organic molecules containing radio-carbon, when these are required.

In addition to radio-isotopes, the Establishment will produce separated stable isotopes of many elements. Research groups are working on the separation of stable isotopes by several methods, including thermal diffusion, fractional distillation and chemical exchange. A thermal diffusion plant for the preparation of enriched oxygen 18 is being built, which should give by autumn 1948 a yield of 1/7 gm. of oxygen 18 per week, at a concentration of 20 per cent. A 34-ft. fractional distillation column, working with liquid carbon monoxide, will be complete in a few months time, and should give a yield of 0·3 gm./day of carbon 13 by the end of the year. A small-scale electro-magnetic separator has been built for other elements, and a much larger instrument, capable of separating any elements, is being erected. Several mass spectrometers are available for assaying samples, and some development work on the design of these instruments is being undertaken.



Van de Graaff high-voltage generator

Electronics

An atomic energy project requires a great variety of electronic instruments, for example, for pile control, radiochemistry, experiments in nuclear physics and health monitoring. A considerable section of the staff is engaged in designing and developing these instruments. In general, the design is carried to a stage where it can be taken over for production by industry, and the Establishment takes the initiative in finding the requirements of university and medical users, so that their needs also can be met in both the design and production stages.

Health

In view of the possible hazards from radiation and radioactive dusts, very stringent precautions are taken at the Establishment, and the health of all workers is the responsibility of a Medical Division. Everybody is given a thorough medical examination on joining the Establishment, and this is repeated periodically. Workers exposed to radiation have their blood examined from time to time to see whether any change occurs in the number of cells, due to exposure to radiation. Safety measures taken have been such, however, that no over-exposure has occurred and there has been no single case of any harmful effects due to radiation.

Arrangements for the monitoring of scientific workers and their laboratories for radioactivity are the responsibility of a Health Physics Group. Staff exposed to radiation carry a photographic film to record the total dosage taken each week, and those working in very active areas carry pocket condenser chambers from which they can see at any time the amount of radiation to which they have been exposed since the chamber was charged. In addition, fixed instruments are placed in the pile buildings, active chemistry laboratories and grounds to provide a continuous record of radiation. Portable instruments are used to make measurements during any operation such as withdrawing materials from a pile. As a result of all these precautions the actual exposure of staff to radiation is well below the levels which have been recommended by the Medical Research Council. The Health Physics Group is also responsible for monitoring the effluent water from the Establishment and seeing that it complies with the rigid specifications laid down by the Medical Research Council.

SOME NEW RHEOLOGICAL PHENOMENA AND THEIR SIGNIFICANCE FOR THE CONSTITUTION OF MATERIALS

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AND

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The materials studied in rheology are of varied constitution, with intricate patterns of constituent components of visible, colloidal, molecular, atomic and sub-atomic sizes. The patterns range from a *coarse-grained* type in which a discontinuous structure is apparent, to a *fine-grained* one which appears homogeneous and continuous to the eye and even to the microscope; the former type is represented by biological tissues, textile materials, natural and synthetic sponges, foams, powders, timber, cement, etc., and the latter by gases, amorphous liquids and solids, single crystals, etc. In the engineering constructions of Nature and man, widespread use is made of coarse- and fine-grained materials, and this invites an investigation into their mechanical properties as exhibited in changes of volume and form, and into the relation between these properties and the constitution of the materials.

In the present article we shall discuss experiments in which we use both types of material, the coarse-grained ones being particularly valuable here because they can be made to give combinations of mechanical properties suited to the purpose in hand and not easily available in the fine-grained types. Moreover, one can easily vary the constitution of a coarse-grained material by physical means and observe macroscopically how the mechanical properties depend on the constitution. As an example, consider coarse-grained sponges of rubber or rubber-like substances. The sponges can be made to display large elastic recoveries of strains for changes of both volume and form, a combination not found in fine-grained materials. Moreover, the sponges can be made in various structural designs, including the extremes of an *open* structure with intercommunicating holes, and a *closed* one with isolated holes, and also covering a wide range of mixed structures in which the holes may be filled with air or viscous or visco-elastic liquids. Another example is provided by the coarse-grained assemblies of fibres, ranging from single hairs to textile fabrics, and yet another by powders, etc. We select from the materials of all types samples of a size sufficiently large to allow a determination of the mechanical properties in terms of a *continuum theory*, the coarse- and fine-grained structures alike being averaged out into continua over regions of macroscopic, microscopic or submicroscopic dimensions. For the coarse-grained materials we can then observe simultaneously the mechanical properties as defined by the continuum theory, and the constitution as revealed by the structural pattern of the components of macroscopic size, and thus have a means of correlating one with the other. For the fine-grained materials we can observe the mechanical properties as before, and elucidate by analogy the correlation with the hidden constitution on a microscopic and submicroscopic scale.

For ease of reference we shall introduce a nomenclature suited to distinguish between different kinds of response to mechanical actions. We have examined all the materials first in their natural state, when they are at rest and free from externally applied forces, and we use the term 'isotropic' to indicate that the material in its natural state displays full spherical symmetry in response to actions along the various directions in space; the term 'compressible' is used to indicate appreciable changes in volume within the range of actions considered; and the term 'shear elastic' to denote in that range an appreciable amount of shear strain recovery under a sudden release of all external forces. By contrast, we use the term 'anisotropic' for a deviation from spherical symmetry, and the terms 'incompressible' and 'shear inelastic' when the changes of volume and of shear strain recovery respectively are inappreciably small.

Continuum Theory of the Elasticity of Volume and Form

In the discussion of a continuum theory of the elasticity of volume and form, we shall restrict ourselves to materials which are isotropic in their natural state, since the theory appears for these materials in its simplest form.

We consider here a differentially small portion of an elastic material. Under an applied load of external forces, the portion will pass from its natural state to some static state of equilibrium, shortly referred to as the 'loaded state', and will appear there as a cube with edges of unit length. In transit from the natural state the cube will have acquired in the loaded state a certain *strain*, according to the changes in volume and form, and a certain *stress*, according to the external forces which appear here as traction forces per unit area acting across the faces of the cube. We can then resolve the strain and the stress into components tangential and normal to three adjacent faces of the cube, arrange these components into two square matrices, and define quantities, termed scalar invariants, which remain unaltered under all changes of orientation of the edges and faces of the cube to which the matrices refer. For a given matrix one can express any arbitrarily considered scalar invariant as a function of three, and only three, mutually independent ones, which are distinguished as the first, second and third in accordance with their degrees in the matrix components, and defined respectively as the sum of the terms in the principal diagonal, the sum of the minors of these terms, and the determinant of the matrix. It is then the task of a continuum theory of elasticity to introduce the laws which relate the matrices of stress and strain to one another.

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The classical continuum theory considers only infinitesimally small strains, and assumes for these the validity of Hooke's law. When we apply this law to isotropic materials, we find that the changes of volume must be independent of the tangential components of stress, and the changes of form must be independent of the normal components. Moreover, the law postulates here that the changes of volume are linearly proportional to the mean *isotropic pressure*, calculated as the arithmetical mean of the normal components of stress, and the changes of form linearly proportional to the *deviatory stress*, calculated by subtracting the mean isotropic pressure from the total stress present; the proportionality factors are known as elasticity moduli of volume and of form respectively.

The general continuum theory[3] by contrast considers strains of any amount, small or large, and makes no assumption as to the validity of Hooke's law. We find then for isotropic materials that the changes of volume and of form become interdependent in the sense that the tangential components of stress make some contribution to the changes of volume, and the normal components of stress make a contribution to the changes of form. Lord Kelvin[2] foreshadowed such a possibility in the following words: "It is possible that a shearing stress may produce, in a truly isotropic solid, condensation or dilatation in proportion to the square of its value". We find a general law, according to which the changes in volume can always be expressed as a function of the three scalar invariants of the matrix which represents the stress. It will be noted that the first invariant of stress is linear, contains only the normal components of stress, and is equal to an isotropic pressure multiplied by the factor three, while the second and third invariants are of degrees higher than one and contain normal and tangential components. For a first-order approximation, such as may be allowed for infinitesimally small strain, we neglect terms of higher degrees in the stress components and so find in accordance with Hooke's law that the changes in volume will depend only on the isotropic pressure. When, however, the strains are of appreciable amount, we must take terms of all degrees into account, and we then find non-Hookean terms in the changes of volume which make these changes disproportional to the isotropic pressure, and dependent on both the shear and normal components of stress. In particular, it is to be expected that under large amounts of strain changes of volume may occur even though the first invariant of stress, and the isotropic pressure, are equal to zero, and further, that even paradoxical effects may be expected in which, for example, the volume is decreased while the isotropic pressure acting across the face of a differential cube is a pull. Such a paradox is resolved when one regards the three different invariants as a result of three different ways of forming mean values by averaging over the full solid angle of directions in space. The first invariant corresponds to a mean of the first powers, that is, to a simple arithmetical mean, while the second and third invariants correspond to means of second and third degrees respectively. In the Hookean postulate it is assumed that, for changes of volume, only the arithmetical mean of the traction forces is of importance, while in the general theory means of higher degrees are also admitted.

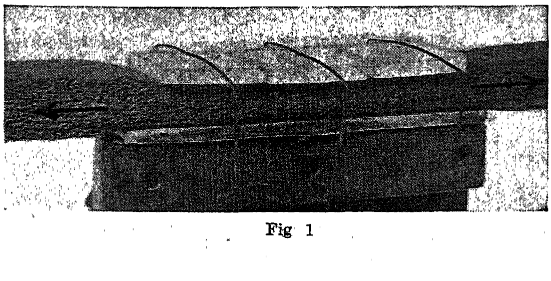
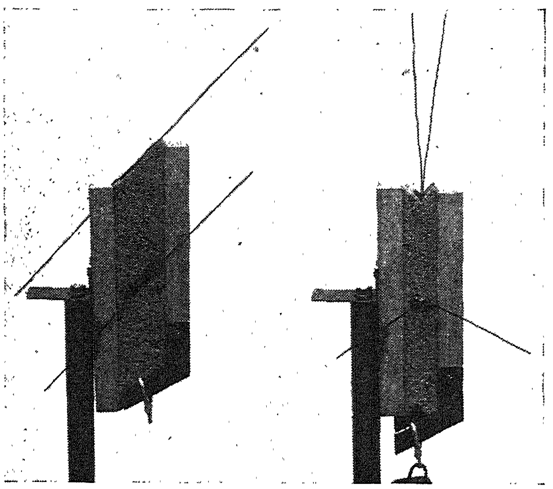


Fig 1



(a) (b)

Fig. 2

To demonstrate experimentally the whole range of effects which are expected in accordance with the general laws we need isotropic materials capable of large elastic recoveries of strain, both in volume and in form. Such materials are available only in a coarse-grained type, and are here provided by the air-filled sponges of rubber with open and closed structures. These sponges show in a striking manner the non-Hookean terms in the changes of volume.

Fig. 1 refers to a sample of sponge rubber which is pulled lengthwise by a 7-lb. weight (indicated by arrows) and simultaneously compressed in height by three blocks of 'Perspex', each loaded by a pair of $\frac{1}{2}$-lb. weights. Attention should be focused on that part of the rubber sponge which lies beneath the middle block, since the blocks on either side are used only as guards intended to secure a nearer approach to homogeneity in the middle. A measurement of the dimensions of the sample reveals that the volume

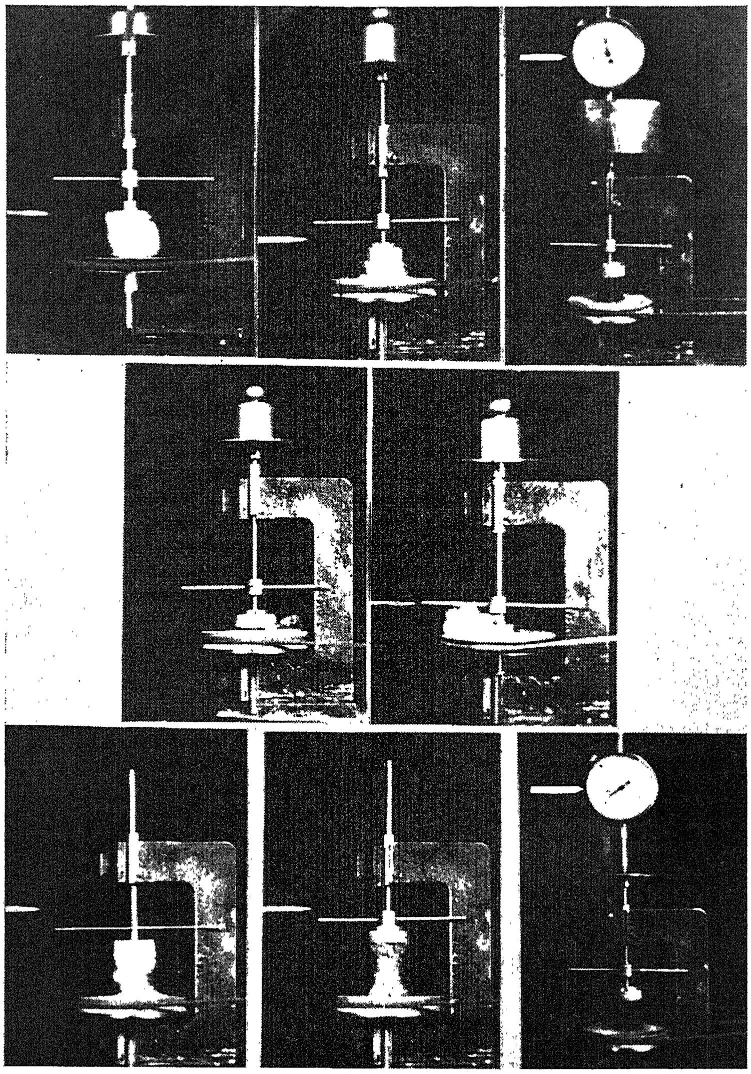


Fig. 3

of the middle part is reduced by about 40 per cent compared with the unstrained state, as the conspicuous decrease in height completely overshadows the changes in the dimensions in length and width. At the same time, the mean isotropic pressure is distinctly in the sense of a pull, since per unit area the lengthwise pulling force is about twenty times as great as the vertical compressive force.

Fig. 2 (*a*) and (*b*) refers to an open sponge rubber cemented between two blocks of wood, the unstrained state being shown on the left (*a*), while on the right (*b*) is the strained state reached when a weight is hung on a bracket fixed to one of the wood blocks. It can be seen that in the strained state the sponge has contracted in all three dimensions, the ends and sides being sucked in, as revealed by the motions of the attached wires, and the thickness being reduced as shown by the decrease in the distance between the wood blocks. In this experiment volume reductions exceeding 40 per cent have been noted, while an examination of the stresses (which is difficult on account of the fact that the stress is heterogeneously distributed in the sponge) shows a mean isotropic pressure in the sense of a pull.

Similar results have been obtained in experiments on samples of sponge rubber of the closed type, and this means that the volume effects shown in Figs. 1 and 2 are by no means restricted to materials with structures in which the changes of volume can occur through an expulsion of the air from the holes in the structure.

Constitution of Matter

In flow experiments on coarse-grained materials, one may observe on a macroscopic scale both the structure and the particular kind of mechanical behaviour displayed, and then correlate one with the other. Such a correlation is difficult to establish for fine-grained materials, since the structure cannot be observed macroscopically. If, however, similarities in behaviour are found between two materials, one visibly discontinuous and the other apparently continuous, the structure which is seen in one provides a possible model (at least) for that which is unseen in the other. (Such an idea appears frequently in scientific literature. H. Mark and F. Eirich used suspensions of elongated particles in liquids to simulate colloidal solution of long-chain molecules, and Sir Lawrence Bragg used groups of soap bubbles to throw light on the sub-visible details of the crystalline structure of metals.) In this way a bridge can be built between the structural and the continuum theories, and an approach made towards finding for the fine-grained materials a correlation between structure and the rheological behaviour.

Preliminary experiments were made to reveal the correspondence in rheological behaviour for the various types of materials here considered.

We first tested the shear elasticity by applying a shearaing ction and observing the recovery of shear strain under a sudden release of all external forces, so distinguishing between shear-inelastic and shear-elastic materials. We thus collected into the shear-inelastic class some types of fine- and some of coarse-grained materials, the former including optically clear brittle solids, Newtonian liquids, and gases, and the latter dry powders such as chalk, glass, etc. Similarly, we were able to group into the shear-elastic class certain fine-grained types, including colloidal solutions of gelatine, cellulose, rubber, saponified oils, etc., and certain coarse-grained types including the rubber sponges (open and closed) and a large variety of assemblies of fibrous constituents, with the fibres occurring as single hairs or yarns, curled up or stretched out, arranged in a random or orderly manner, varying in length from a millimetre to several metres and composed of wool, cotton, rayon, silk, metal, asbestos, etc.

We then tested the compressibility of the materials and drew a dividing line between the materials termed incompressible and those termed compressible. To a first approximation the dividing line can be drawn so that we find on the side of the incompressible materials fine- and coarse-grained types which are wholly in the condensed states, that is, solid, liquid or intermediate, while on the side of the compressible materials we find the types which are wholly or partly in gaseous states. The division is particularly interesting for the shear-elastic class, in which we find that the types of fine-grained materials considered, namely, the colloidal solutions, are wholly condensed and thus incompressible, whereas the coarse-grained types of rubber sponges and fibrous assemblies contain gases (air) and are accordingly compressible.

On the basis of the classification given above, we can predict in a qualitative way the behaviour under various conditions of the materials within one class and division. We shall illustrate these predictions by describing for the coarse- and the fine-grained materials of the same class experiments under conditions chosen first so that all the materials behave alike because of their class resemblance in shear elasticity[1,3], and secondly, so that they behave differently on account of the additional complications caused by the differences in compressibility.

In the experiments illustrated in Fig. 3, an upright cylindrical specimen of the material considered was subjected to torsion between two parallel disks, the lower one fixed in height but capable of rotation, and the upper one free to move up and down but prevented from rotating. This was achieved by mounting the lower disk on top of a pulley, and securing the upper disk to a stem which slides in a sleeve and carries a crossbar which is checked by the supporting frame. The cylindrical wall of the specimen was left open to the atmosphere. Experiments were performed with various materials including liquids, fibrous assemblies and rubber sponges, but only the shear-elastic materials are shown since the others produce effects of a merely trivial kind. To apply the torsion it is necessary that the material should stick to the disk. For the liquid no special measures are required, but for the fibres it is necessary to face the disks with glass paper, and the sponges must be secured by cementing (thanks are due to Messrs. Dunlop Rubber Co., Expanded Rubber Co., and B.B. Chemical Co., who supplied us with a wide range of sponges, expanded rubbers and adhesives). The photographs show the results of the application of torsion. The pointer on the left-hand side of a picture indicates the original height of the top disk by pointing to the original position either of the crossbar, or of the hand of the dial-gauge.

The first row shows three pictures referring respectively to a fine-grained material, namely, a colloidal solution, and to two coarse-grained materials, namely, a fibrous assembly and a sponge with a closed structure. The materials are subjected to torsion while at the same time they are compressed by a weight. Under these conditions the materials develop stresses which drive them inwards to such an extent as to push the top disk upwards against the action of the weight. The amount by which the top disk rises differs in the three cases, being greatest for the colloidal solution, less for the fibrous assembly and so small for the sponge as to require a dial gauge to reveal it. For the colloidal solution, the torsional motion has to be maintained at constant velocity during the exposure, as otherwise the liquid would lose its stress and run out of the gap. (It is particularly striking that the stresses hold this material in place despite the opposing influence of gravitational and centrifugal forces.) On the other hand, the sponge is a solid which is subjected to a static torsion. The fibrous assembly can be treated as a solid or a liquid, and the torsion applied statically or dynamically.

The second row of pictures shows a visco-elastic liquid and a fibrous assembly. The arrangements are similar to those used for the previous experiments, except that now the speeds and other conditions of the experiment are so chosen that a disturbance occurs in the form of an eddy which rolls the material up and then ejects it from the gap. The photographs were taken at the instant of ejection. No exact theory has yet been developed to account fully for this phenomenon, which occurs exceptionally in liquids but commonly in the fibrous assemblies; it was first observed by K. Weissenberg and R. J. Russell on some specially prepared visco-elastic liquids.

All the photographs so far discussed show the similarity between the coarse- and fine-grained materials. By contrast, the third row shows the additional complication produced in the coarse-grained materials because of their compressibility. The specimens are a fibrous assembly, an open sponge and a closed sponge, in all cases cemented to the disk and treated as solids. A statical torsion has been applied; but in this case without weighing down the top plate. All the materials are again drawn inwards, but the upper disk is pulled down, that is, in the opposite sense to that shown before. It is evident that the materials have been reduced in volume by the waisting and reduction in height.

From the experimental observations cited, it may be concluded that a wide range of structures of cellular or fibrous type provide possible models for the hidden molecular structure of the apparently continuous colloidal solutions in the shear-elastic class. Such models would be insufficiently resistant to changes in volume, and it would be necessary to provide for the missing resistance by appropriate assumptions.

Thanks are due to the director of the Shirley Institute for giving us the opportunity to carry out this work and permission to publish it. We are indebted to Mr. C. Bradley and Miss J. Gallagher for the photographs accompanying this article.

[1] Freeman, S. M., and Weissenberg, K., *Nature*, **161**, 324 (1948).

[2] Thomson, Sir W., "Math. and Phys. Papers", III, XCII, Part 1, 34.

[3] Weissenberg, K., *Nature*, **159**, 310 (1947).

BRITISH ASSOCIATION

BRIGHTON MEETING

THE programme for the 110th Annual Meeting of the British Association for the Advancement of Science has now been published. The meeting will be held in Brighton during September 8–15, under the presidency of Sir Henry Tizard, who will deliver an address on "The Passing World" in which he will review some of the outstanding features of the progress of science and technology in Great Britain from the close of a period of stagnation towards the end of the nineteenth century.

The meeting will be held, as usual, in thirteen concurrent sections with a number of joint sessions, and the programme also includes evening discourses and a session of the Division for Social and International Relations of Science, at which Dr. Julian Huxley and others from Unesco will discuss "Science Across the Frontiers".

The sectional programmes contain a wide variety of topics, ranging from cosmic magnetism to the effects of the cinema on young people. The objects of the annual meetings of the Association being to provide opportunities for men of science to meet each other and discuss their work in the setting of science as a whole, to allow men of science and laymen to meet each other, and to increase the public understanding of science, the programme includes both specialist and general topics (nearly three hundred speakers).

Among the former are sessions on recent advances in the crystalline state, opened by Sir Lawrence Bragg, geology and air photography, functional morphology (including an address by Prof. H. Graham Cannon), the denudation of the weald, applicable mathematics, the case for and against the metric system, transmission of effects from the endings of nerve fibres (opened by Sir Henry Dale), recent advances in colour vision (including an address by Prof. H. Hartridge), to mention only a few.

The more general topics include industrial applications of electronic devices (with exhibition), new metals in industry, new building materials, problems of Colonial development, movements of population, fuel economy with special reference to the heat pump, human blood groups, problems of old age. Various aspects of food and nutrition will be discussed at several sessions arranged by the Sections of Zoology, Economics, Physiology, Agriculture and Chemistry, and the programme also includes discussions and talks on science in industry as arranged by no fewer than seven sections.

Arrangements have been made for sixty excursions and a number of social engagements, and the members will be entertained at a civic reception in the buildings on the Royal Pavilion Estate.

Further details of the meeting may be obtained from the Secretary of the British Association, Burlington House, London, W.1 (Regent 2019). There is no closing date for registration, and hotel accommodation is still available in Brighton.

THE SWEDISH DEEP-SEA EXPEDITION

By Prof. HANS PETTERSSON
Göteborg

AN account has already been given of the first part of the cruise of the *Albatross* (see *Nature*, October 25, 1947, p. 559). On August 27, 1947, the *Albatross* started from Balboa on its cruise across the Pacific Ocean, and five months later terminated it in the idyllic harbour of Ternate, visited by the *Challenger* Expedition seventy-three years earlier. The course led first to the Galapagos Islands, where the upwelling cold water and the deposits beneath it were studied; then along a west-north-west direction until the eighteenth parallel was reached, from there turning south for Nukuhiva and for Tahiti. Between Tapeete and Honolulu the course of the *Challenger* was followed, although to the opposite direction, several of its stations being repeated under way. From Honolulu the course lay to the south-south-west and, after crossing the equator for a fourth time, we steered west-north-west, finally reaching the great deeps south-east of Mindanao.

Our four first crossings of the counter-equatorial current were used for a close study of its hydrography by frequent deep series, intercalated by bathythermograph shots through the uppermost 140 metres. Interesting results are shown by our diagrams, as the signs of upwelling and descending water in the regions of divergence and convergence respectively in the surface. A distinct oxygen minimum extended from a few hundred metres downwards for 800 m. or more. Clouds of suspended particles studied by the Tyndall method were met with also at great depths.

The ruggedness of the sea bottom revealed by our echograms often proved an obstacle to coring operations, as were also the not infrequent encounters with hard bottom (lava beds) at great depths, sometimes leading to partial or total loss of the steel coring tubes. Nevertheless, fifty-seven cores, varying in length from a few metres to fifteen metres, were raised from depths between 2,000 and nearly 8,000 m., their total length approaching 500 metres. Many of them, especially those taken near the equator, showed a pronounced stratification indicating changes of surface conditions affecting the distribution of plankton organisms. A special feature on our echograms near the regions of divergence at the surface were diffusely reflecting layers in a depth of 100–250 metres, presumably fish shoals or masses of other pelagic organisms. Attempts to sample these reflecting layers failed for lack of suitable gear.

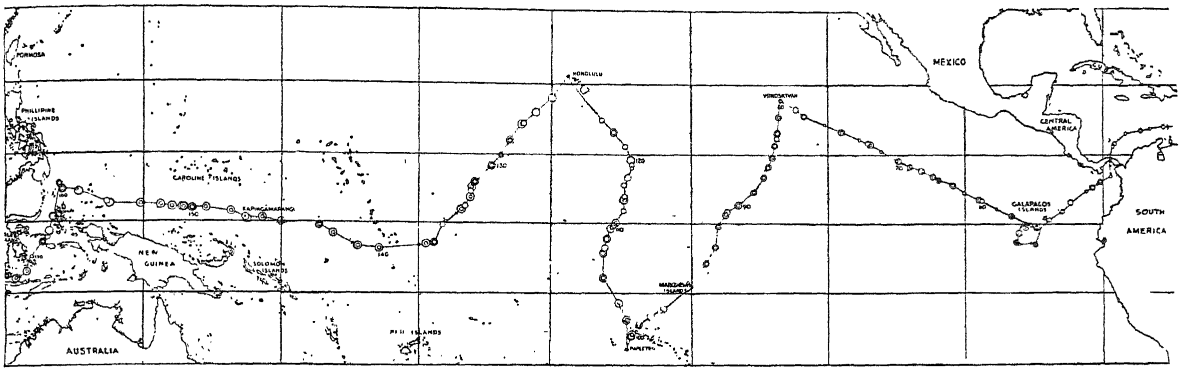
Landings made at different ocean islands afforded opportunities for making botanical collections and photographic studies of animals and plants.

Measurements of the thickness of sediment by means of recording echoes from exploding depth charges were made frequently along our course. Except near Panama, where higher values were found, no reflecting layers could be discovered below the 1,000-ft. level, in striking contrast with the much deeper echoes found in the Mediterranean and in the open Atlantic Ocean.

After proceeding through the Sunda Archipelago to Soerabaya, raising sediment cores displaying volcanic ash layers and taking hydrographic soundings under way, the expedition started on its cruise into the Indian Ocean on February 18, 1948, from Bali. Strong winds, approaching hurricane force in the squalls, made work impossible during the first week; but afterwards weather conditions were ideal. Such was not the case, however, with the state of the sea bottom, the ruggedness of which made both core sampling and measurements of sediment thickness precarious. The number of cores raised from the eastern Indian Ocean was therefore unexpectedly small—a total length of only 60 metres—and the loss of instruments was relatively heavy.

An interesting feature on our echograms was a perfectly flat bottom at a depth of about 4,300 metres, which extended for several hundred nautical miles from near the equator towards the coast of Ceylon, where the depth over long stretches did not vary by more than a few fathoms. Here the core sampler was broken in two, proving that the bottom was hard, with very thin cover of sediment (an extensive lava bed ?).

Following from Colombo a course towards the south-south-east, we again passed over the southern hemisphere, afterwards setting course for the Seychelles. The cores raised from the western Indian



Track of the *Albatross* across the Pacific. The circles indicate the stations occupied

Ocean were more numerous than in its eastern parts ; and especially after leaving the Seychelles on a northerly course over the Somali Deep they displayed very pronounced stratification. In the Gulf of Aden as well as in the southern part of the Red Sea in its northern part, the rocky nature of the bottom made core-sampling precarious—the lowest parts of the cores frequently gave off a smell of sulphureted hydrogen, indicating a deficient oxygenization of the bottom waters.

As earlier in the Pacific, our numerous soundings of the thickness of sediment made in the Indian Ocean gave very moderate depths for the reflecting layer, rarely exceeding 200 metres and frequently less than 100 metres.

The hydrographic soundings included two sections across the equatorial current system, where again indications of fish-shoals (or other densely packed pelagic organisms) were found on the echograms. The *Albatross* was considerably delayed coming up the Red Sea by a strong northwester, and arrived at Suez on May 8, having thus devoted two and a half months to the Indian Ocean and to the Red Sea.

OBITUARIES

Sir Clifford Paterson, O.B.E., F.R.S.

Sir Clifford Copland Paterson, director of the Research Laboratories of the General Electric Co., Ltd., Wembley, died at the Watford Peace Memorial Hospital on July 26, shortly after returning from Australia, where he had been acting as contact between British and Australian scientific bodies.

Born on October 17, 1879, Paterson was educated at Mill Hill School and Finsbury Technical College under Silvanus Thompson. After serving a four-year apprenticeship in an engineering works in London he obtained further practical experience in Glasgow and at the Oerlikon Works in Switzerland, going afterwards to Faraday House under Dr. Alexander Russell. From 1903 until 1919 he was principal assistant to Sir Richard Glazebrook at the National Physical Laboratory, and was responsible for the electro-technical and photometric departments. Under his guidance these departments made outstanding contributions in precision methods of measuring electrical power and the establishment of the international standard of light. The Paterson–Walsh electric height finder for indicating automatically the heights of aircraft was developed during the First World War.

Paterson joined the General Electric Co., Ltd., in 1919 to establish the research laboratories of that Company, of which he was made a director in 1941. The progress of so highly technical an industry as electrical engineering depends essentially on scientific research, and the research laboratories which grew up around the achievements and personality of Paterson are representative of the finest of their kind. Starting with a staff of twenty-nine, the General Electric Research Laboratories now employ 1,750 people. Working under the inspiration and guidance of Paterson a distinguished team have made valuable contributions to developments ranging from heavy engineering to electronics. In lighting and vision, fields in which Paterson's greatest personal contributions to science were made, they have been outstanding, as well as in many other branches of applied physics.

The successful prosecution of the War demanded the speedy solution of new problems requiring the application of scientific principles. Radar was a notable example—employed first for the detection of enemy aircraft, then for naval purposes for detection and intricate gun ranging. In this and in many other directions, the facilities and the personnel of the General Electric research organisation under Paterson's direction were a great national asset.

Paterson was a man of great personal charm. His high principles and great integrity in his business, professional and personal relations were so well recognized by all with whom he came into contact that there is no need to stress them. His wide interests and the confidence imposed in him and the esteem with which he was regarded are reflected in the numerous high offices which he held in his profession, and the honours and awards conferred upon him. He was a past president of the Institution of Electrical Engineers, the Institute of Physics, the Electrical Research Association, the Illuminating Engineering Society, the International Commission on Illumination, the Institution of Illumination Engineers in Charge, and the Junior Institution of Engineers. He had been vice-president of the Royal Institution and chairman of council of the British Standards Institution. He was on the Advisory Council of the Department of Scientific and Industrial Research and a member of the Executive Committee of the National Physical Laboratory. He received the degree of D.Sc. (*honoris causa*) of the University of Birmingham in 1937, he was elected to the fellowship of the Royal Society in 1942, awarded the Faraday Medal of the Institution of Electrical Engineers in 1945, and the Ewing Medal by the

Council of the Institution of Civil Engineers in 1947. He was knighted in 1946. The last of his many honours, the Gold Medal of the Illuminating Engineering Society of America, was presented shortly before his death.

He was immensely proud of the City of London's tribute to him when during the last two years of the War he was Master of the Worshipful Company of Tallow Chandlers.

Paterson was a notable and delightful lecturer, and was at his best when his subject lent itself to experiment and demonstration. Among his outstanding lectures and papers may be mentioned the Faraday Lecture of the Institution of Electrical Engineers, "The Free Electron"; the Guthrie Lecture, "The Appraisement of Lighting"; the J. J. Thomson Jubilee Lecture, "The Electron Liberated"; and the British Association York Meeting, "The Use of Photocells".

Opportunities for relaxation and recreation to a man of Paterson's capacity for devotion to the service of his Company and the profession of which he was so distinguished a member were few; but his hobbies of gardening and yachting were a never-failing source of interest and delight to him. His garden, which Lady Paterson and he planned themselves, and the original formation of which was largely the result of their own labours, was much admired by all who were privileged to see it. The majority of his holidays were spent in his yacht on the River Deben at Waldringfield.

By Paterson's death the engineering profession suffers an inestimable loss. The records of his work remain, and are available. Through the great organisation which he built up his influence will be perpetuated; but we shall miss his sound and mature counsel, which grew out of his accumulated experiences and widespread contacts and activities.

Lady Paterson, two sons and a daughter survive him.

A. P. M. FLEMING

Mr. J. R. Cowie

ON August 5, Mr. John R. Cowie died aged sixty-six leaving a widow, two sons and one daughter. Chairman of the Council of the Electrical Research Association since the spring of this year, he had been a member of the Council since 1924. This long association with industrial research was particularly concerned with circuit-breaking phenomena and switchgear, which was the first and remains the largest item of research and development in the Association's programme.

Mr. Cowie was especially qualified for leadership both by experience and character. A native of Scotland, he was educated in Edinburgh (Watson's and the Heriot-Watt College) and Glasgow. Apprenticed to William Thomson and Co., he also worked with the British Electric Plant Co., and William Beardmore and Co., before joining the Glasgow Corporation, where he was associated with the late Mr. Lackie and Sir Archibald Page and concerned, *inter alia*, with the Dalmarnock power station and the raising of steam pressures. He joined A. Reyrolle and Co. twenty-seven years ago and was southern area manager at the time of his death. During this period he was associated with most of the great electrical developments in London and in the South and West of England and Wales. He served on the Council of the Institution of Electrical Engineers during 1919–22, and in 1937 was president of the Association of Mining Electrical and Mechanical Engineers. His influence in the electrical industry was great. Few leading engineers had the same depth of experience and association with great and new projects both on the supply and the manufacturing sides. No one was more trusted or, indeed, more trustworthy. In negotiation and in matters of discretion his wise counsel and his strong principles were ever in request. His clearness of thought, sincerity and frankness of expression were nevertheless allied to great kindliness. He was a loyal friend and his help was freely given to those who approached him. His subordinates thought as highly of him as his colleagues. He was esteemed not only by engineers but also by those he met in his many sports and hobbies—rugby, hockey, golf, fishing, horticulture and dog-breeding. His convictions inspired respect and his character affection.

S. WHITEHEAD

WE regret to announce the following deaths:

Dr. P. R. Lowe, O.B.E., formerly keeper in charge of ornithology, British Museum (Natural History), on August 18, aged seventy-eight.

Prof. A. F. C. Pollard, emeritus professor of physics in the Imperial College of Science and Technology, University of London, on August 15, aged seventy.

Prof. S. W. J. Smith, F.R.S., emeritus professor of physics in the University of Birmingham, on August 20, aged seventy-seven years.

NEWS and VIEWS

Sociology in the London School of Economics: Prof. D. V. Glass

THE University of London has just established a new chair of sociology, tenable at the London School of Economics, and has elected Dr. D. V. Glass as the first occupant. This, the third chair in sociology in the School, is designed to promote teaching and research in the sociology of contemporary society and in current methods of collecting and analysing data obtainable by field studies and social surveys. It is therefore a post which offers great opportunities, and Dr. Glass' experience is particularly relevant. He is well known as a demographer of international repute, his most substantial work in this field being "Population Policies and Movements in Europe". He has for many years been research secretary of the Population Investigation Committee and was put in charge of the Family Census by the Royal Commission on Population. His interests have always been more in the social aspects of population than in pure statistical demography. He served his apprenticeship in social research under Prof. Lancelot Hogben, undertaking studies of educational opportunity in Great Britain, and he also published a little book on "The Town" in 1935. All this suggests that he is likely to turn his attention to such questions as family and household structure, local and occupational groups, and social mobility and stratification. These are all eminently subjects for the study of which the chair has been instituted.

The British Institute of Archæology, Ankara: Mr. Seton Lloyd

MR. SETON LLOYD, who (as announced in *Nature* of August 14, p. 250) has been elected to the directorship of the recently founded British Institute of Archæology in Ankara, started his career as architectural assistant to Sir Edwin Lutyens, and gained his early archæological experience in Egypt during the late 'twenties. During 1930–37 he worked under Dr. Henri Frankfort, as field supervisor to the Iraq Expedition of the Chicago Oriental Institute, and there gained an exceptionally detailed knowledge of mound-excavation on a wide variety of Mesopotamian sites. During this period he had the satisfaction of recovering many now famous art treasures from the rich Sumerian temples of Tell Asmar and Tell Ajrab. Next came two seasons with the Neilson Expedition under Prof. J. Garstang at Mersin in Turkey, where a stratified excavation of extreme complexity gave full scope to his particular talent. Since 1939, as technical adviser to the Directorate of Antiquities in the Government of Iraq, he has been indirectly responsible for a succession of astonishingly successful excavations, which have not only preserved the continuity of archæological discovery, but also raised his Department from a mere administrative service to a unique position as a research institution. Indeed, it would be difficult to over-estimate the debt which Mesopotamian archæology already owes to Mr. Lloyd's technique and the new generation of Iraqi excavators to his guidance. His name is now coupled with those of Mallowan and Woolley as one of the most gifted and successful excavators of our age. On him devolves the task of training those of the coming generation, and it could not be in better hands. His publications show him to be a good all-round archæologist and good artist, with a scholarly as well as a scientific outlook. The new Institute thus makes an auspicious start.

Botany in Nigeria: Prof. F. W. Sansome

THE new University College in Nigeria is fortunate to have secured Dr. F. W. Sansome as its first professor of botany. Dr. Sansome received his undergraduate training in Edinburgh as an agriculturist. Upon this foundation he added, at first in Glasgow and later at the John Innes Horticultural Institution, a thorough training in botany and genetics. At this time Dr. Sansome carried out important work on tetraploidy in tomatoes, and published (with Dr. Philp) "Recent Advances in Plant Genetics", which rapidly ran through two editions. He then became senior lecturer in the Botany Department in the University of Manchester, and assistant director of the Experimental Grounds, with responsibilities in horticultural botany and genetics. He devoted his energy, with great success, to the building up of facilities for horticultural research, and the Jodrell Bank Station owes its efficiency to Dr. Sansome's work. Dr. Sansome's infectious enthusiasm has endeared him to horticulturists and students in the north of England, and his wisdom and wit and generosity are greatly appreciated by his colleagues. The good wishes of professional botanists and a large general public will accompany him on his new venture. It is a pleasure to know that his wife, who is distinguished for her research on cytology, is to be a research fellow in Ibadan, and will continue her work there.

Veterinary Science in Bristol: Prof. F. Blakemore

IN 1943 the Committee on Veterinary Education, of which Dr. T. Loveday was chairman, recommended that a new school of veterinary science should be established in the University of Bristol. With the concurrence of the Ministry of Agriculture and Fisheries and of the University Grants Committee, the University has undertaken to carry out this recommendation. Plans are far advanced for the additional buildings required, and the small estate of Langford is available as a field station. It is proposed to admit students to the first year of study in the autumn of 1949. The University has recently appointed, as its first professor of veterinary medicine, Mr. F. Blakemore, who is at present superintending veterinary investigation officer for England and Wales. Mr. Blakemore received his veterinary education at the Universities of Liverpool and Manchester. After some experience in practice he served as veterinary officer for the county of Glamorgan, and as veterinary investigation officer for the Eastern Provinces. In 1946 he was appointed to the post he now relinquishes. He has been responsible for the teaching of general hygiene in the University of Cambridge. Mr. Blakemore has carried out extensive work on fowl paralysis and on various diseases of lambs, calves and pigs. He was the first to identify fluorine poisoning of stock in Great Britain and has traced its relation to industry. Recently he has been engaged in the study of mineral deficiency diseases in cattle.

Marin Mersenne (1588–1648)

ON September 1 occurs the tercentenary of the death of the French ecclesiast, mathematician and philosopher, Marin Mersenne, whose correspondence with his contemporaries, published in 1933–37, sheds much light on the history of physical science. Born on September 8, 1588, at La Souitiède, Sarthe, he was educated at the Jesuit College at La Flêche, where for a short time he had Descartes—eight years his junior—as a school-fellow. From La Flêche, Mersenne went to Paris to study at the Sorbonne, and about 1616 entered the religious order of Minim Friars, an offshoot of the Franciscans. From 1616 until 1619 he was professor at the College of Nevers and thence onwards was superior of the Convent of his Order in Paris. He travelled into Germany, Holland and Italy, translated Galileo's "Mechanics", and held small gatherings of mathematicians and the like in his room in the Convent, thus anticipating the inauguration of the Royal Academy of Sciences.

Auguste Henri Forel

NEUROLOGIST, psychiatrist, entomologist, eugenist, temperance and penal reform advocate, Auguste Henri Forel was born a century ago, on September 1, 1848, at Morges, Canton Vaud, in Switzerland. His childhood studies of ants culminated in the publication, at the age of twenty-six, of "Les Fourmis de la Suisse", of which Darwin confessed that seldom in his life had he been more interested by any book. Studying medicine at Zurich, Forel specialized in psychiatry and was appointed professor of psychiatry in the University and director of the Insane Hospital. The more important works of this indefatigable and versatile man include "Der Hypnotismus und die Suggestive Psychotherapie" (1889), "Hygiene der Nerven und des Geistes" (1903) and "Die Sexuelle

Frage" (1905). The last was translated into sixteen languages, and the year of his death witnessed the publication of a sixteenth edition. It was described by Havelock Ellis as "without doubt the most comprehensive, and taking into account its many-sidedness, perhaps the ablest work which has yet appeared on the sex question". When he was fifty, Forel gave up teaching and devoted himself to the pursuit of his bewildering variety of interests. In 1912 he had a stroke, which resulted in permanent paralysis of his right hand. To the literature of autopathography he contributed an interesting account of his dysphasia in the *Journal für Psychologie und Neurologie*, of which he was founder and editor. His autobiography "Out of My Life and Work" (English translation, 1937) is a frank and fascinating self-portrait of one of the most picturesque scientific figures of modern times. He died in 1931.

The *Philosophical Magazine*: 150th Anniversary

THE *Philosophical Magazine* was first published in 1798, and the board of directors and the editorial board have every reason to be proud of the journal's record during its long life of a hundred and fifty years. The title-page to the first volume indicates a breadth of interest "comprehending the various branches of science, the liberal and fine arts, agriculture, manufactures and commerce". Succeeding volumes of the *Magazine* have achieved for it an international reputation as a scientific journal in the realm of physical and mathematical science. David Brewster, John Tyndall, William Thomson, Oliver Lodge, J. J. Thomson are names to be found in the list of editors who succeeded Alexander Tilloch and Richard Taylor, and it is not surprising that such men of science have been responsible for the publication of important papers by research workers in various fields, including those of relativity and atomic physics. The traditionally high standard of the *Philosophical Magazine* has been well maintained, and we wish the periodical every success on the journey towards the two hundredth anniversary of its foundation.

To mark the hundred and fiftieth anniversary of the founding of the *Philosophical Magazine*, a special commemoration number has been edited by Dr. Alan Ferguson under the general title "Natural Philosophy through the Eighteenth Century and Allied Topics" (Pp. viii+164. London: Taylor and Francis. 15*s*.). This is a most useful survey, and includes articles on astronomy through the eighteenth century by Sir H. Spencer Jones, physics by Prof. Herbert Dingle, chemistry by Prof. J. R. Partington, and mathematics by Dr. J. F. Scott. An appropriate review by Engineer-Captain Edgar C. Smith provides interesting material on the achievements of civil engineering. Among the allied topics dealt with are: scientific instruments by Mr. Robert S. Whipple, the scientific periodical from 1665 to 1798 by Dr. Douglas McKie, and the teaching of the physical sciences at the end of the eighteenth century by Dr. F. Sherwood Taylor. The whole volume is both interesting and instructive, containing a wealth of information which enhances its value as a book of reference.

The Night Sky in September

NEW moon occurs on Sept. 3d. 11h. 21m., U.T., and full moon on Sept. 18d. 09h. 43m. The following conjunctions with the moon take place: Sept. 4d. 18h., Mercury 3° S.; Sept. 6d. 22h., Mars 0·7° S.; Sept. 10d. 13h., Jupiter 4° N.; Sept. 29d. 13h., Venus 6° S.; Sept. 30d. 05h., Saturn 4° S. In addition to these conjunctions with the moon, the following conjunctions take place: Sept. 9d. 10h., Saturn in conjunction with Regulus, Saturn 0·8° N.; Sept. 20d. 16h., Mercury in conjunction with Spica, Mercury 0·2° S. Mercury sets at 19h. 15m., 18h. 45m. and 17h. 52m. at the beginning, middle and end of the month, respectively, and is too close to the sun for favourable observation. The planet reaches its greatest eastern elongation on Sept. 25. Venus is a morning star, rising at 1h. 15m., 1h. 30m. and 1h. 55m. at the beginning, middle and end of the month, respectively; it has a stellar magnitude of approximately − 3·8 throughout most of September, and can be observed with phase a little more than half moon most of the time. The planet attains its greatest western elongation on Sept. 3. Mars sets at 20h. 10m. and 18h. 50m. at the beginning and end of the month, respectively, and is too close to the sun for favourable observation. Jupiter can be seen for some time after sunset, the times of setting being 22h. 25m. and 20h. 40m. on Sept. 1 and 30, respectively, but the planet lies rather low for good observation in northern latitudes. Saturn rises at 4h. 10m. and 2h. 35m. at the beginning and end of the month, respectively, and can be seen as a morning star, stellar magnitude 0·9. One occultation of stars brighter than magnitude 6 occurs as follows: Sept. 27d. 01h. 43·5m., 47 Gemi. (*R*), where *R* refers to reappearance; the latitude of Greenwich is assumed. Autumnal equinox commences on Sept. 23d. 03h.

Announcements

DR. G. H. S. BUSHNELL has been appointed curator of the Museum of Archæology and Ethnology in the University of Cambridge.

Mr. B. C. Clayton and Mr. V. D. O. Smyth have recently been appointed advisory officers at the Research Station of the Board of Greenkeeping Research, St. Ives Research Station, Bingley, Yorkshire.

UNDER the auspices of the Society of Chemical Industry, a conference on "Dust in Industry" will be held at the University of Leeds during September 28–30. Further information can be obtained from the General Secretary, Society of Chemical Industry, 56 Victoria Street, London, S.W.1.

A CONFERENCE on "Modern Applications of Liquid Fuels" will be held at the University of Birmingham during September 21–23, under the joint auspices of the Institute of Petroleum and the Institute of Fuel. The president will be Mr. J. A. Oriel. Further information can be obtained from Mr. R. W. Reynolds-Davies, General Secretary, 18 Devonshire Street, London, W.1.

A CONVENTION on "High Vacua" will be held at Gleneagles, Perthshire, during October 12–13, under the presidency of Sir Charles Darwin. Further information can be obtained from Mr. L. L. Maitland, British-American Research, Block E.2, Hillingdon North, Glasgow, S.W.

A DISCUSSION on "Meteors" will be held in the Physical Laboratories of the University of Manchester on September 9. It will be opened by Dr. F. L. Whipple of Harvard University; other speakers will include Mr. J. P. M. Prentice, Dr. J. G. Porter, Mr. N. Herlofson and Dr. A. C. B. Lovell. Further information can be obtained from Dr. Lovell at the above Laboratories.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Behaviour of a Particle of Very Small Mass in a Magnetic Field

It would seem at first sight that a particle of very small mass, such as accompanies β-disintegration or electron-capture, and significant magnetic moment μ, would be very difficult to observe. According to Bethe[1], it should have a fairly high ionizing power and a correspondingly small penetration into matter. Moreover, if it already possesses a charge e, the uncertainty principle should play a part in all cases where experimental evidence on μ would be sought[2]. However, for an ultra-relativistic particle (that is, a particle with a high ratio of kinetic mass to rest mass) special considerations come into play which may modify the generally accepted conclusions.

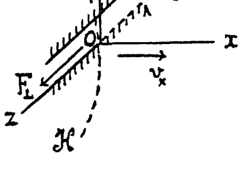
A Dirac particle can be considered as a spherule which is both magnetized and carries an electric charge. As Frenkel[3] has pointed out, if the particle has a magnetic moment $\vec{\mu}$, an electric moment $\vec{\pi}$, of the same order of absolute value, must necessarily appear. Moreover, when the speed approaches c, the three vectors $\vec{\mu}$, $\vec{\pi}$ and $\vec{c}$ tend to become orthogonal[4]. The magnitude of the moment $\vec{\mu}$ should vary with the speed if it could have any direction whatever. However, in the case where the moment $\vec{\mu}$ is orthogonal to the direction of the displacement, the former has the properties of invariance, as described by Louis de Broglie[5], who pointed out that the densities of moments $\vec{\mu}$ and $\vec{\pi}$ form the six components of an antisymmetrical tensor of the second order: the main moments that are obtained by integration from these densities have invariant values. Thus, in the relativistic case, moment $\vec{\mu}$ would always tend to follow the orthogonal direction and to be invariant in this.

Let us write the uncertainty relation in a new form that is better adapted to high speeds:

$$\Delta x \,.\, \Delta\eta \geqslant \frac{h}{m_0 c}\,, \text{ where } \Delta x \,.\, \Delta v \geqslant \frac{h}{m_0\eta^3} \qquad (1)$$

$$(\text{for } \Delta p = m_0 c \,.\, \Delta\eta = m_0\eta^3\,\Delta v).$$

In the diagram, particles (e,μ), with a speed v_x in the direction Ox, cross a long slit in the Z direction which has the width Δy.



The Lorentz force at the origin O is $F_L = ev_x\,H(O)$. The width Δy of the slit introduces in this force an uncertainty

$$\Delta F_L = e\left[v_x\left(\frac{\partial H}{\partial y}\right)\Delta y + H(O)\Delta v_x\right],$$

which we must compare to the force F_S due to spin. The ratio of these forces, with $\mu = eh/4\pi m_0$, will be

$$\frac{\Delta F_L}{F_S} = \frac{4\pi m_0}{h}\left[v_x\Delta y + \frac{H}{\partial H/\partial y}\,\Delta v_x\right], \qquad (2)$$

putting, from (1),

$$\Delta y \geqslant \frac{h}{m_0\eta^3\Delta v_y} \text{ and } \Delta v_x \geqslant \frac{h}{m_0\eta^3\Delta x}. \qquad (3)$$

(2) then becomes

$$\frac{\Delta F_L}{F_S} \geqslant \frac{4\pi m_0}{h}\left[\frac{h}{m_0\eta^3}\cdot\frac{v_x}{\Delta v_y} + \frac{h}{m_0\eta^3}\,\frac{H}{\partial H/\partial y}\,\frac{1}{\Delta x}\right], \text{ or}$$

$$\frac{\Delta F_L}{F_S} \geqslant \frac{4\pi}{\eta^3}\left[\frac{v_x}{\Delta v_y} + \frac{H}{\partial H/\partial y}\,\frac{1}{\Delta x}\right].$$

The term in brackets being obviously greater than 1, we finally get

$$\Delta F_L/F_S \geqslant 4\pi/\eta^3, \qquad (4)$$

and the magnetic moment μ will be observable if

$$\eta^3 \geqslant 4\pi, \qquad (5)$$

a condition that is obviously fulfilled for every relativistic particle.

The magnetic moment of a charged light particle might thus be found.

Even if we deny invariance to the magnetic moment and allow that its absolute value might decrease as the kinetic mass of the particle increases, the various expressions which have been given[6] for the conditions of observability remain, with a power of η diminished by one unit, and the conclusions are unchanged.

The foregoing considerations are of a very general character. The question will be examined afresh with the Dirac method. On the other hand, I shall shortly show that a relativistic particle may give a weaker ionization when traversing matter than was previously thought. This arises both because of the orthogonal relation of the electric moment $\vec{\pi}$ to $\vec{\mu}$ and $\vec{c}$, and because of the contracting of the magnetic and electric lines of force in a plane normal to the direction of its displacement.

J. Thibaud

Institute of Atomic Physics,
University of Lyons,
1 rue Raulin, Lyons.
May 8.

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[2] Darwin, *Proc. Roy. Soc.*, A, **130**, 637 (1931). Pauli, W., Congrès Solvay de 1930 (Gauthier-Villars, Paris).

[3] Frenkel, *Z. Phys.*, **37**, 4–5, 243.

[4] de Broglie, L., "L'Electron Magnetique", 192 (Hermann, 1934).

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Feret's Statistical Diameter as a Measure of Particle Size

Various measures of the size of irregularly shaped particles as seen in profile under the microscope have been used, chosen according to their theoretical significance or practical ease of measurement. These include, using Heywood's notation[1,2]: (i) the diameter of the circle of equal area, d; (ii) the diameter of the circle of equal perimeter, D; (iii) the length of line bisecting the profile area (Martin's statistical diameter[3]), M; and (iv) the perpendicular distance between parallel tangents touching opposite sides of the profile (Feret's statistical diameter[4]), F. M and F

are determined for randomly oriented particles, thus giving an average value over all possible orientations. d is usually regarded as the ideal measure of particles seen in profile, but is somewhat difficult to determine experimentally with precision. It is, however, common practice when sizing very small particles to estimate d visually by comparing them with standard reference circles on a Patterson and Cawood or similar type of eyepiece graticule[5,6]. M and F are convenient to measure in practice with aid of an eyepiece scale or filar micrometer, and have been extensively used by various workers. D, or rather the ratio D/d, termed by Heywood[1] the 'contour ratio', and its reciprocal called the 'degree of circularity' by Wadell[7], have been used in discussing the shape and hydrodynamical properties of particles. For these purposes D has usually been determined by direct perimeter measurement of the projected images of particles. It does not appear to have been adopted intentionally in any work known to me as a direct single measure of particle size.

In fact, it can be shown that D and F are equivalent measures provided that the particle profile is non-re-entrant, a condition which is usually satisfied. This simple identity seems to have been overlooked hitherto in particle-size work. Elementary calculation will demonstrate the relationship for simple geometrical outlines, for example, triangle or rectangle, orientated in all possible directions. The proof in the more general case follows readily by considering each element of the perimeter separately. The three-dimensional equivalent of this result is already well known, namely, that the mean projected area of a three-dimensional particle averaged over all orientations is equal to one quarter of the total surface area of the particle, again with the condition of non-re-entrancy. This latter relationship has been much used in the determination of the specific surface of suspended particles by light obscuration methods[8]. Both results follow from two mathematical theorems given by Cauchy in 1841 [9]. The second of these theorems is discussed by Vouk[10].

In a recent paper, Heywood[2] has discussed the various methods of measuring microscopical particles. Judging other measures by comparison with the mean projected diameter, d, as standard, he concludes: "The Feret definition of statistical diameter is not recommended on account of the large positive error introduced for elongated particles". Interpretation of the Feret diameter as $1/\pi$ of the perimeter shows that no general correspondence with d can obtain for particles of differing shape; but it gives this statistical diameter an important new significance, particularly in connexion with the specification of particle shape and correlated properties.

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Projected Area of Convex Bodies

IN connexion with photometric determination of specific surface of finely divided material, it is essential to know the relation between the projected area of particles, which is actually measured, and the corresponding surface area. The solution of this problem was first given by A. Cauchy in his "Memoire sur la rectification des courbes et la quadrature des surfaces courbes" (Paris, 1832)[1]. A short account of his results in the form of theorems was later published in the *Comptes rendus*[2], but no formal proof was given. It is the latter paper which is usually referred to in connexion with the above problem.

The relevant theorem states that

$$S = 4\bar{A}, \qquad (1)$$

where S is the surface area and $\bar{A}$ the average projected area of the convex body. The average is taken over all possible orientations in space. Although this result has been much used and discussed by many experimental and theoretical workers[3], there still seems to be much confusion and uncertainty as to its general validity. Thus in *Nature* recently[4], Dr. B. A. Scott says that it can be shown that the ratio of surface to projected area for a rectangular parallelepiped in random motion is $18\pi/(8+\pi)$ independent of the relative lengths of the axes. Dr. Scott uses this result to compute the surface area of calcined and hydrated alumina, and obtains a very good agreement between the estimates of the surface area obtained from optical measurement and other methods. Since similar work is going on in our laboratory, Dr. Scott's statement induced us to examine once more the literature on Cauchy's theorem, and we came to the conclusion that an error must have crept into Dr. Scott's calculations.

Since the original Cauchy's papers are not easily accessible and the discussion of the problem presented therein is not always easy to follow, we think it worth while to give a short proof of equation (1) in a slightly different form from that given by Cauchy.

Consider a convex body having a surface area S. Suppose there are no re-entrant surfaces, that is, the surface S cannot be pierced by a straight line on more than two points. We divide S into a large number of infinitesimal surface elements, which can be represented by a vector $\overrightarrow{d\sigma}$ having the direction of the outward normal to the surface element and the magnitude numerically equal to its area. The projection dA of such an element on a fixed plane P specified by its normal $\vec{n}$ is given by the absolute value of the scalar product $|\overrightarrow{d\sigma} \cdot \vec{n}|$. For the sake of simplicity, we shall suppose that the plane P is perpendicular to one of the axes (for example, the x-axis) of a rectangular co-ordinate system x,y,z. The components of the vectors $\overrightarrow{d\sigma}$ and $\vec{n}$ will then be given by: $\overrightarrow{d\sigma} = d\sigma\ (\sin\vartheta \cos\varphi \vec{i} + \sin\vartheta \sin\varphi \vec{j} + \cos\vartheta \vec{k}$, and $\vec{n} = \vec{i}$, where $\vec{i}, \vec{j}, \vec{k}$ are unit vectors in directions of the co-ordinate axes, and ϑ and φ are the angles which the vector $\overrightarrow{d\sigma}$ forms with positive z and x axes. Since all orientations of the surface element are equally likely, the average value of the projection of $\overrightarrow{d\sigma}$ on the plane P is given by:

$$\overline{dA} = \frac{1}{4\pi}\iint\limits_{\omega} |\overrightarrow{d\sigma}\,.\,\overrightarrow{n}|\,d\omega, \qquad (2)$$

where $d\omega$ is the element of solid angle ($= \sin\vartheta\, d\vartheta\, d\varphi$) and the integration has to be carried out over the total solid angle 4π. Now in optical problems the surface element will contribute to the projection of the body only if its orientation is such that the angle between $\overrightarrow{d\sigma}$ and $\overrightarrow{n}$ is less than $\pi/2$. Therefore, the right-hand side of equation (2) should be multiplied by a factor 1/2. Thus we have

$$\overline{dA} = \frac{d\sigma}{2\pi}\int\limits_0^{\pi}\int\limits_0^{\pi/2} \sin^2\vartheta \cos\varphi\, d\vartheta\, d\varphi. \qquad (3)$$

The integration of (3) gives

$$\overline{dA} = 1/4\, d\sigma. \qquad (4)$$

Now if there are no re-entrant surfaces, we can consider the elements of the surface of a convex body as giving equal contributions independent of each other to the total average projected area of the body, and we can write

$$\overline{A} = 1/4 \iint\limits_{\sigma} d\sigma, \qquad (5)$$

and the proof of the relation (1) is completed.

In the presence of re-entrant surfaces, equation (5) is not valid, since the contributions from different surface elements cannot be taken as independent. Our assumption that a given surface element contributes to the projected area only if the angle between vectors $\overrightarrow{d\sigma}$ and $\overrightarrow{n}$ is less than $\pi/2$ is no longer true. There will be some orientations of the body in which some of the surface elements will not make any contribution, although their normals form with the normal of the fixed plane P an angle less than $\pi/2$, because of the obscuration effect. Therefore the ratio of the projected to the surface area for such bodies will always be less than 1/4.

For polyhedra it is not necessary to subdivide the surface in infinitesimal elements $d\sigma$. It suffices to calculate the contribution from each of the n faces separately, and to replace the integral in equation (5) by a summation.

The validity of relation (1) can also be shown by computing the projected area of the body as a whole, and integrating over all possible orientations. This method was used by Cauchy in his original paper (1) in the case of an ellipsoid. The calculation is easy for such simple bodies as the cube, the parallelepiped, the prism or the cylinder, but for more complicated polyhedra it becomes very tedious.

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Proton Bombardment of Fluorine

CAPTURE γ-rays have been detected in the proton bombardment of most of the light nuclei from Li^7 to Cl^{37}. The yield from a thick target for a single level in the compound nucleus is proportional to:

$$\Gamma_p\Gamma_\gamma/\Gamma. \qquad (1)$$

The presence of a competing mode of disintegration only reduces this yield as much as it increases the total width Γ. Thus, in the case of F^{19}, the most probable transmutation is the short-range α-emission:

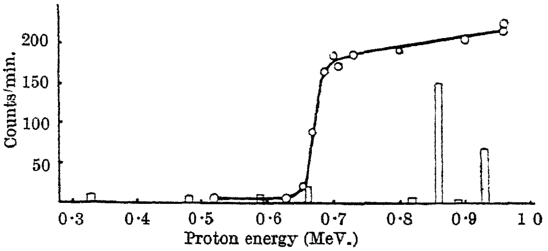
$$F^{19} + H^1 \rightarrow Ne^{20*} \rightarrow O^{16*} + He^4$$
$$O^{16*} \rightarrow O^{16} + h\nu \text{ (6 MeV.)}; \qquad (2)$$

but this should not decrease the probability of γ-emission from the levels of Ne^{20} produced by protons of more than about 600 keV., for in this energy region we expect the proton width Γ_p to exceed the short-range α-particle width Γ_α; and the total width Γ will be determined largely by the former.

The high yield of 6 MeV. γ-rays from (2) does, however, make it difficult to observe the expected capture γ-rays:

$$F^{19} + H^1 \rightarrow Ne^{20*} \rightarrow Ne^{20} + h\nu \qquad (3)$$
$$(Q = 12{\cdot}8 \text{ MeV.}).$$

We used the (γ,n) reaction in Cu^{63} as a threshold (10·9 ± 0·3 MeV.)[1] detector, counting the resulting 10·5-min. activity on thin-wall aluminium β-counters. The accompanying graph gives our results, and also indicates the positions and relative yields of the resonances for process (3)[2]. The shape of the rise between 630 and 700 keV. was compared with the rise in the yield of the 6 MeV. γ-rays, measured simultaneously with a Geiger-Müller γ-counter, and agreement was good. The slow rise between 700 and 960 keV. may be the result of a dirty target, or may indicate the emission of γ-rays from the broad levels[3,4] of Ne^{20}. In either case, it is clear that there is no yield of high-energy γ-rays from the other resonances of reaction (3), comparable with the yield at the 660 keV. resonance.



o, Cu^{62} activity; ⊓, short-range α-particle resonances

The energy available for this transition, 13·4 MeV., does not greatly exceed the threshold of the detector; and Dee, Curran and Strothers[5] found no γ–γ coincidences from fluorine bombarded with protons. It is thus probable that the γ-ray that we detect is the full energy transition to the ground-state.

Having the 590 and 862 keV. resonances available for background runs with the high intensity of 6 MeV. γ-rays alone present, we were able to measure the higher energy γ-rays by the coincidence absorption method, using two Geiger-Müller counters. By this means the angular distribution of the capture γ-ray was found to be isotropic, intensities at 0°, 45° and 90° to the proton beam direction being equal within a probable error of 10 per cent. The yield at the 660 keV. resonance was estimated at 2·2 ± 0·8 per cent of the 6 MeV. γ-rays, giving a radiation width of the order of 2 eV. for this level of Ne^{20}, and less than 0·1 eV. for the others up to 1 MeV. proton energy. This yield is consistent with our measurements with the copper detector if the (γ,n) cross-section of Cu^{63} is about $1 \cdot 5 \times 10^{-27}$ cm.^{2} at this energy[6].

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Polarization of Annihilation Radiation

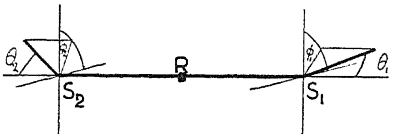
AN attempt has been made to detect the relative polarization of the two photons of energy 0·51 MeV. produced in the annihilation of slow positrons. If pairs of quanta from a source of annihilation radiation at R (Fig. *a*) are scattered at S_1 and S_2, theory[1-3] predicts an angular distribution of quanta after Compton scattering given by the formula

$$N(\theta_1\varphi_1\theta_2\varphi_2)d\Omega_1 d\Omega_2 = k\left\{\frac{[(1-\cos\theta_1)^3+2]\,[(1-\cos\theta_2)^3+2]}{[2-\cos\theta_1]^3\,[2-\cos\theta_2]^3} - \frac{\sin^2\theta_1\,\sin^2\theta_2\,\cos 2\,(\varphi_1-\varphi_2)}{[2-\cos\theta_1]^2\,[2-\cos\theta_2]^2}\right\}d\Omega_1 d\Omega_2,$$

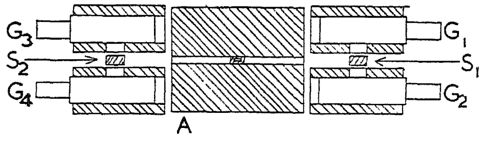
where θ_1 and θ_2 are the angles through which the quanta are scattered, φ_1 and φ_2 are the azimuthal angles measured in a plane perpendicular to the direction of incidence (S_1RS_2), and $N(\theta_1\varphi_1\theta_2\varphi_2)d\Omega_1 d\Omega_2$ the probability of the two quanta being scattered into elements of solid angle $d\Omega_1$ and $d\Omega_2$ in the directions $(\theta_1\varphi_1)$, $(\theta_2\varphi_2)$.

The apparatus for the experimental verification of this formula is sketched in Fig. *b*. Positron-active material, packed into an aluminium tube, is placed at the centre of the lead block A. Oppositely directed quanta pass down the collimating channel to strike the cylindrical scatterers S_1 and S_2. Lead shields define the solid angles into which quanta must be scattered to reach the Geiger counters G_1, G_2, G_3 and G_4. Coincident discharges of either G_1 or G_2 with either G_3 or G_4 are recorded when all four counters lie in the same plane (coplanar position), and when one pair of counters is rotated through 90° about $S_1 S_2$ (perpendicular position), corresponding to mean values of $(\varphi_1-\varphi_2)$ of 0° and 90° respectively. The total numbers of discharges in each pair of counters (of which 70 per cent are due to quanta scattered by S_1 or S_2) are recorded and used to calculate corrections for source decay and chance coincidences.

Sources of Cu^{64} (12·8 hr. half-life) were prepared by deuteron bombardment of copper in the Cambridge cyclotron; each had an initial activity of about 3×10^8 positrons per sec., and gave useful counting rates over a period of 36 hours after irradiation. The results from thirteen such sources are condensed into the accompanying table. The first results were obtained with brass scatterers 1 in. long and 0·6 in. in diameter; later, aluminium scatterers of the same dimensions were used to minimize the effect of double scattering. Two different arrangements of lead shields surrounding the counters were used, the first defining rather larger solid angles for detection of the scattered quanta than the second. Corrections have been made for source decay, chance coincidences, and a background-rate of 3 per hr. due to cosmic rays. The net coincidence-rates at the beginning of each run were of order 0·5 per min. The errors quoted are standard deviations calculated assuming normal statistical fluctuations, and are compatible with the variations in the results from individual sources.



(a)



(b)

Scatterer material		Brass	Brass	Aluminium
Lead shield arrangement		Wide angle	Narrow angle	Narrow angle
$\dfrac{\text{Counting-rate (perpendicular pos.)}}{\text{Counting-rate (co-planar pos.)}}$	(theory)	1·55	1·82	1·86
,, ,, ,, ,,	(experimental)	1·39 ± 0·07	1·31 ± 0·17	1·51 ± 0·10

The results establish the existence of a relative polarization. Further experiments are needed, however, to determine whether the discrepancies between theoretical prediction and experimental results are merely instrumental, or due to a breakdown of theory.

The deviations appear too large to be dismissed as due to statistical fluctuations, especially as the independent results using different scatterers are all consistently lower than the theoretical predictions. Any double scattering of quanta within the scatterers would tend to reduce the observed ratio; the increase in the observed ratio with the lower density scatterers may be significant. A rigorous calculation of such an effect is not feasible; rough calculations indicate that it should not be serious. The Geiger counters are being replaced by scintillation counters; an expected twenty-fold increase in detection efficiency will permit the use of smaller scatterers of low-density material, more close defined geometry, and increased counting-rates, and so settle definitely whether or not the theoretical predictions are quantitatively correct.

Note added in proof, August 21. The results of Bleuler and Bradt[4] are noted. Their value for the ratio of perpendicular to coplanar coincidence-rates, while in agreement with theory, has a sufficient margin of error to be compatible with the results quoted here.

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Origin of Cosmic Ray Stars

As yet, the absorption of the star-producing radiation has only been measured in air. Nevertheless, the variation of the intensity of single tracks recorded in photographic plates under various lead absorbers has been measured at high altitude and at sea-level[1,2]. The decrease of single tracks with a given lead absorber is found to be much less than the decrease of stars in an equal weight of the atmosphere. Perkins[2] has shown that the number of single tracks is proportional to the number of stars, and therefore it appears established that the range of the star-producing component of cosmic radiation expressed in gm./cm.^{2} is larger by a factor of approximately 3 in lead than it is in air.

This difference in range could be caused possibly by the difference in (*a*) density, or (*b*) atomic weight, A, of the two materials. Perkins has assumed the former and has concluded that the stars are produced by an unstable particle. It seems worth while to explore the latter possibility, as this leads to a dependence of the range of the primaries on A, not very dissimilar from that found experimentally.

Thus, it is well known that the nuclear radius is approximately proportional to $A^{1/3}$:

$$R = r_0 A^{1/3}, \text{ with } r_0 \sim 10^{-13} \text{ cm.} \qquad (1)$$

The cross-section, σ, will be πR^2, and the number of nuclei per gm./cm.^{2}, n, will be N/A, where N is Avogadro's number. Hence the mean free path for a radiation interacting strongly with the nuclei will be given by:

$$l = 1/n\pi R^2 \text{ gm./cm.}^2, \text{ or } l = A^{1/3}/N\pi r_0^2 \text{ gm./cm.}^2. \qquad (2)$$

Substituting numerical values, one obtains:

$$l_{\text{air}} = 130 \text{ gm./cm.}^2, \; l_{\text{lead}} = 311 \text{ gm./cm.}^2, \; l_{\text{lead}}/l_{\text{air}} = 2{\cdot}5,$$

which do not differ greatly from the observed values.

Thus, as an alternative to the assumption of unstable primaries, one may equally well assume the primaries to be stable particles having a cross-section for star production given by the so-called geometric cross-section, and hence a range given by (2).

From the known constitution of the Ilford nuclear emulsion, one obtains for the range of the primaries in the emulsion on this basis:

$$l_E = 200 \text{ gm./cm.}^2 = 50 \text{ cm.}, \qquad (3)$$

since $\rho_E = 4$. Let S be the number of primaries crossing 1 cm.^{2} per day, and I the number of stars formed per c.c. per day. Then approximately:

$$S/l_E = I. \qquad (4)$$

Now, at Jungfraujoch, $I \sim 10$ stars/c.c./day, and hence:

$$S \sim 500/\text{cm.}^2/\text{day}, \qquad (5)$$

or, in other words, about 12 per cent of the total corpuscular radiation at this altitude.

This is in rough agreement with Schopper's estimate[3] of the intensity of fast neutrons, based on measurements of the number of recoil protons recorded in plates covered with paraffin. Thus, the assumption that the majority of cosmic ray stars are caused by fast neutrons is not in violent disagreement with the existing data.

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Random Association of Points on a Lattice

A LATTICE is defined to be a rectangular array of points each of which may be any one of k colours. In a previous communication[1], I have given the first and the second moments for the probability distribution of the total number of joins between points of different colours, when the probability that any point is of colour r is $p_r \left(\sum_1^k p_r = 1\right)$ and is independent of the colour of all the other points. A join was there defined as a line between two adjacent points parallel to the axes of the lattice. The present note gives the first and the second moments for the distribution of (1) the number of joins between points of the same colour, and (2) the total number of joins between points of different colours for two- and three-dimensional lattices when all possible joins between adjacent points are included. The first distribution corresponds to Todd's distribution of 'doublets'[2].

(1) *Joins between points of the same colour, say, rth colour.*

(*a*) Two-dimensional lattice: $m \times n$ points:

$$\begin{aligned} \mu_1' &= (4b - 3a + 2)\, p_r^2, \\ \mu_2 &= (4b - 3a + 2)\, p_r^2 \\ &\quad + 8(7b - 9a + 11)\, p_r^3 \\ &\quad - 15(4b - 5a + 6)\, p_r^4. \end{aligned}$$

(*b*) Three-dimensional lattice: $l \times m \times n$ points:

$$\begin{aligned} \mu_1' &= (13e - 9d + 6c - 4)\, p_r^2, \\ \mu_2 &= (13e - 9d + 6c - 4)\, p_r^2 \\ &\quad + 2(325e - 378d + 432c - 488)\, p_r^3 \\ &\quad - (663e - 765d + 870c - 980)\, p_r^4. \end{aligned}$$

(2) *Total number of joins between points of different colours.*

(*a*) Two-dimensional lattice: $m \times n$ points:

$$\begin{aligned} \mu_1' &= 2(4b - 3a + 2)\, \Sigma p_r p_s, \\ \mu_2 &= 2(32b - 39a + 46)\, \Sigma p_r p_s \\ &\quad - 8(39b - 48a + 57)\, \Sigma p_r p_s p_t \\ &\quad - 60(4b - 5a + 6)\, \Sigma p_r^2 p_s^2 \\ &\quad + 120(4b - 5a + 6)\, \Sigma p_r p_s p_t p_u. \end{aligned}$$

(*b*) Three-dimensional lattice: $l \times m \times n$ points:

$$\begin{aligned} \mu_1' &= 2(13e - 9d + 6c - 4)\, \Sigma p_r p_s, \\ \mu_2 &= 2(338e - 387d + 438c - 492)\, \Sigma p_r p_s \\ &\quad - 2(1677e - 1926d + 2184c - 2456)\, \Sigma p_r p_s p_t \\ &\quad - 4(663e - 765d + 870c - 980)\, \Sigma p_r^2 p_s^2 \\ &\quad + 8(663e - 765d + 870c - 980)\, \Sigma p_r p_s p_t p_u. \end{aligned}$$

In all these expressions, $a = m + n$, $b = mn$, $c = l + m + n$, $d = lm + mn + nl$, and $e = lmn$. The summations are taken for all values of r, s, t and u such that $1 \leqslant r < s < t < u \leqslant k$.

All the distributions tend to the normal form when l, m and n tend to infinity.

The corresponding results when the lattices consist of a fixed number of points of the various colours, say $n_1, n_2, \ldots n_k$, have also been worked out. These results, being long and complicated, will be given in another communication to be published shortly.

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Oxford. April 9.

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Difference – Differential Equations

The general linear homogeneous difference – differential equation with constant coefficients is

$$\Lambda(y) \equiv \sum_{\mu}\sum_{\nu} a_{\mu\nu} y^{(\nu)}(t + b_\mu) = 0, \qquad (1)$$

where $0 \leqslant \mu \leqslant m$, $0 \leqslant \nu \leqslant n$, $y^{(\nu)}(t)$ is the ν-th derivative of the unknown function $y(t)$ and $0 = b_0 < b_1 < \ldots < b_m$. Particular examples of this equation have appeared in radiology[1,2], economics[3,4] and the theory of control mechanisms[5,6]. The most useful 'boundary conditions' are also the most convenient from the theoretical point of view; we suppose assigned the values of $y(t)$ in an initial interval $0 \leqslant t < b_m$. In terms of these given values, we define a function

$$\varphi(s) = \sum_{\mu}\sum_{\nu} a_{\mu\nu} \exp(b_\mu s) \times$$
$$\left\{ \int_0^{b_\mu} y^{(\nu)}(u) e^{-su} du + \sum_{\lambda=0}^{\nu-1} s^{\nu - 1 - \lambda} y^{(\lambda)}(0) \right\}.$$

(In particular cases this usually reduces to something fairly simple.) It is obvious that $y = \exp st$ is a solution of (1) for any s satisfying

$$\tau(s) \equiv \sum_{\mu}\sum_{\nu} a_{\mu\nu} s^{\nu} \exp(b_\mu s) = 0.$$

The zeros of $\tau(s)$ are infinite in number; but their asymptotic behaviour is readily calculable[7]. Under suitable conditions, the solution of (1) is

$$y(t) = \sum_{s} \frac{\varphi(s) \exp st}{\tau^1(s)}, \qquad (2)$$

where s runs through all the zeros of $\tau(s)$. I here assume that $\tau(s)$ has no double zero; if it has, a slight modification must be made in the corresponding term. The series in (2) is convergent and its sum is $y(t)$ (i) for all t, if $a_{mn} \neq 0$ and $a_{0n} \neq 0$, and (ii) for all $t > b_m$, if $a_{mn} \neq 0$. (2) was first given by Hilb[8], but under conditions which would exclude most of the applications. A detailed proof of its validity under the conditions stated will be published shortly[9].

The most interesting question about $y(t)$ is how it behaves when t is large and, in particular, whether $y(t)$ becomes small, periodic or large. This requires a study of the zeros of $\tau(s)$. In any particular case the behaviour of the large zeros can be determined from Langer's theory[7]. If these zeros all have their real parts negative, so that the corresponding terms in $y(t)$ are damped, attention must be directed to a finite number of non-large zeros. This problem for the particular cases in which

$$\tau(s) \equiv s(s + \alpha)e^s + \beta_1 + \beta_2 s + \beta_3 s^2$$

and

$$\tau(s) \equiv s^2 (s + \alpha_1)e^s + (\beta_1 + \beta_2 s)(\alpha_1 + \alpha_2 s)$$

has been discussed by Hartree and others[5,6]. Another special case, into which the equations occurring in radiology[1] and in economics[3,4] may be trivially transformed, is the equation

$$y'(t + 1) + \alpha y(t) = 0 \qquad (\alpha > 0).$$

For this, $\tau(s) \equiv se^s + \alpha$. If $\alpha < \frac{1}{2}\pi$, all zeros of $\tau(s)$ have their real parts negative and $y(t) \to 0$ as $t \to +\infty$, whatever the initial conditions. If $\alpha > \frac{1}{2}\pi$, at least two zeros of $\tau(s)$ have their real parts positive and $y(t)$ oscillates with increasing amplitude as $t \to +\infty$, except under very special initial conditions. For $\alpha = \frac{1}{2}\pi$, there is a periodic solution $y = A \sin(\frac{1}{2}\pi t + B)$ with arbitrary A and B, and the general solution approaches this as t becomes large. There is a periodic solution for $\alpha = 2k\pi + \frac{1}{2}\pi$, where k is any whole number, but the general solution oscillates infinitely unless $k = 0$.

The non-homogeneous equation

$$\Lambda(y) = v(t), \qquad (3)$$

where $v(t)$ is a known function, can also be solved for those $v(t)$ which have a readily calculable Laplace transform. Of course, if any particular solution of (3) can be found, the problem of finding the general solution, or the solution satisfying 'boundary conditions' of our type, is reduced to the same problem for (1), just as in the theory of differential equations.

More substantial and more interesting problems are presented by linear difference – differential equations with variable coefficients[10] and by non-linear equations[11]. The only published application of such a non-linear equation known to me occurs in Lord Cherwell's investigations by probability methods into the distribution of prime numbers[12].

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April 26.

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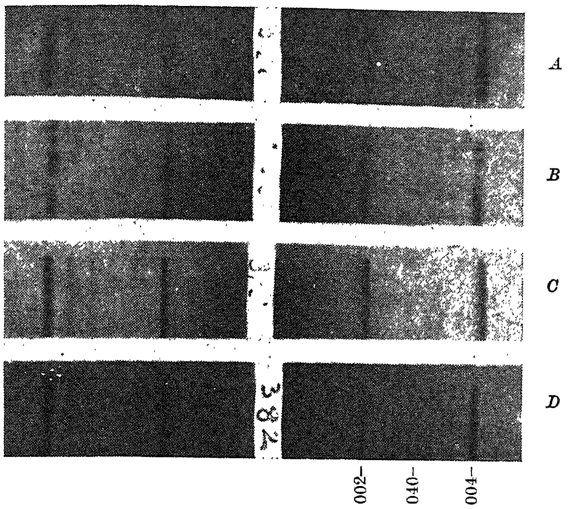
X-Ray Diffraction Effect Shown by some Specimens of Chrysotile

In a study of the 'tailed' spots occurring on X-ray fibre photographs of chrysotile a camera with a slit approximately 0·7 cm. high was used, so that nearly 1 cm. of the fibre was irradiated. The purpose was to obtain lines instead of spots in the X-ray photograph, and thus facilitate photometry. The lines obtained, however, were beaded, the effect being particularly evident with specimens from Barberton (Figs. *A* and *B*). A specimen from Thetford showed only a slight variation in intensity along the lines (Fig. *C*), and a Russian specimen showed no visible variation. The effect can be imitated to some extent by pinching at regular intervals a specimen not showing it (Fig. *D*).

The beadiness seems to be due to a fairly regular variation of the scattering power along the fibres, possibly due to variation in external conditions during their growth. It is not due to multiple foci in the X-ray tube or irregularities in the slit system, since the beads move up and down with the specimen when its position is changed; they are not shown by all specimens, and are independent of the tube and camera used. It is unlikely that they are caused by non-uniform mechanical deformation of the fibres in detaching them from the lump, since they were shown by a specimen 0·10 cm. × 0·14 cm. in cross-section, which was quite rigid and could not bend to any extent during detachment.



(*A*) Specimen of chrysotile from Barberton, South Africa. (*B*) Another specimen from Barberton. (*C*) Specimen from Thetford, Canada. (*D*) Specimen *C*, pinched at intervals

We are grateful to Dr. F. A. Bannister, of the British Museum (Natural History), for verifying the existence of the beadiness with his apparatus, and to Dr. F. J. North, of the National Museum of Wales, for the gift of specimens. Part of the apparatus used was purchased with a grant from the Royal Society

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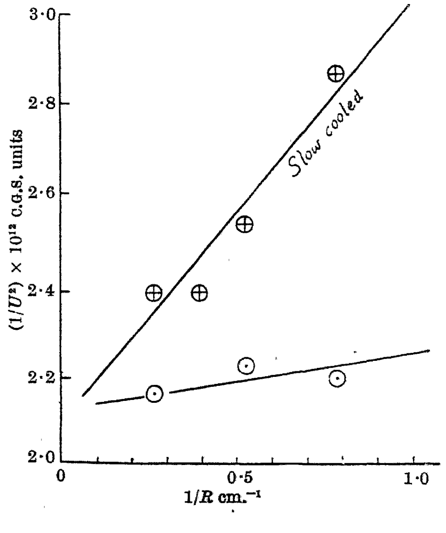
Low-Order Detonation in Solid High Explosives

THE recent communication[1] of Jones and Mitchell reporting the existence of a specific stable 'low' velocity of detonation in the case of crystalline or granulated T.N.T. is of considerable interest in that it emphasizes the importance of grain size in low-density unconfined charges. I have obtained similar results in the case of heavily confined cast T.N.T. charges, in which the grain size can be varied over fairly wide limits by variation in casting technique and alteration in the rate of charge cooling.



Velocities of detonation were measured over 30-cm. intervals by the Dautriche method with calibrated I.C.I. Cordtex as the standard detonant. Heavy copper confinement (3·2 gm./sq. cm. of charge surface) was employed, and measurements were made at a number of different charge diameters. The detonation velocities obtained with two widely different rates of charge cooling are summarized in the accompanying graph. It will be seen that plots of $1/U^2$ against $1/R$, where U is the observed velocity of detonation and R the charge radius, are approximately linear in character; but the slope of the line increases markedly with decreased cooling rate. The two experimental lines thus obtained are, of course, only two representatives of an infinite number possible between certain limits. These 'low' detonation velocities obtained by slow cooling were apparently stable in the sense that no change in velocity could be detected over 24 in. of charge length. The reduction in detonation velocity effected by slow cooling was very considerable, amounting to as much as 850 m./sec. at a charge diameter of 1 in., and cannot, therefore, be explained in terms of density changes, since these were very slight even at the slowest cooling rates.

Hydrodynamical calculations of detonation velocity assume that decomposition occurs at constant volume, under which condition it is dependent only on the heat of detonation and the density of the explosive. It has been known for some time, however, that in the case of solid high explosives, the detonation velocity normally decreases with decreasing charge radius. The best explanation of these detonation values lower than the hydrodynamic detonation velocity is on the basis of the lateral energy loss hypothesis of H. Jones[2]. In the case of solid high explosives, decomposition rarely occurs at constant volume since the process of chemical decomposition requires a very small but nevertheless finite time for completion. There is, therefore, behind the detonation front a region of finite length where equilibrium conditions have not yet been established, and which is usually termed the reaction zone. As a result of the very high pressures developed, some lateral expansion of the detonation products may occur in the region of the reaction zone, that is, before decomposition is complete, so that the maximum temperature and pressure are not developed. This will result in an energy decrease at the detonation front, with an attendant diminution in the velocity with which the detonation wave is propagated through the explosive.

The lateral energy losses will be a function of: (1) the charge radius; (2) the degree of confinement; (3) the 'reaction time' of the explosive, or the time required for the primary decomposition process, since this will determine the length of the reaction zone, and hence the time during which 'effective lateral expansion' can occur.

From the present series of experiments, in which considerable velocity changes have been produced at constant charge diameter and confinement by alteration in the rate of charge cooling, it would appear that the 'reaction time' of cast T.N.T. is a function of the rate of charge cooling. Since it is well established that the crystal size is very dependent on the rate of charge cooling, it seems very probable that the 'reaction time' of cast T.N.T. is a function of crystal size, increasing with increasing crystal size. The bearing of this crystal size – reaction time relationship on the mechanism of the detonative decomposition and the physico-chemical processes occurring in the detonation wave will be discussed fully in a paper to be published shortly.

I acknowledge my thanks to the Chief Scientist, Ministry of Supply, for permission to publish this letter.

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April 17.

[1] Jones, E., and Mitchell, D., *Nature*, **161**, 98 (1948).

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Anomalous Magneto-Resistance Effects in Bismuth

THE change of electrical resistance of bismuth in magnetic fields has been extensively studied, and the investigations of Kapitza[1] and subsequent workers on single crystals have led to the conclusion that the increase in resistance is proportional to the square of the field-strength in weak fields, becoming linear in strong fields. In the course of an investigation into the behaviour of thin fibres of bismuth, we have obtained results which indicate that in certain circumstances the resistance may undergo a small decrease at low field-strengths.

Fibres of bismuth in an envelope of soda glass may be prepared by hot-drawing and a wide variation in diameter is readily obtainable. The range in our experiments was about 5–150 μ. For various orientations of the magnetic field the resistance has been measured as a function of the angular displacement of the specimen. With the axis of rotation parallel to the specimen and perpendicular to the field, the resistance 'cycles' have a periodicity of π. A typical example is shown in Fig. 1.

Comparison of such results with those obtained for single crystals[2] leads to the conclusion that, in general, the fibres are single crystals with the main cleavage plane parallel to the axis.

For a given orientation, the resistance may be plotted against field-strength. In the case of certain fibres the curve so obtained is anomalous in that the change of resistance is negative for a certain range of field strength. The effect is illustrated in Fig. 2, which was obtained with a fibre orientation corresponding to the minimum of Fig. 1.

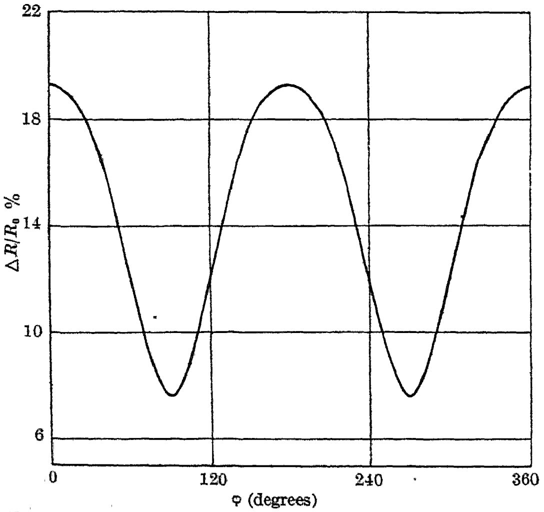

Fig. 1. Variation of resistance with orientation of field for a field of 6,300 oersteds (R_0 = 42 ohms)

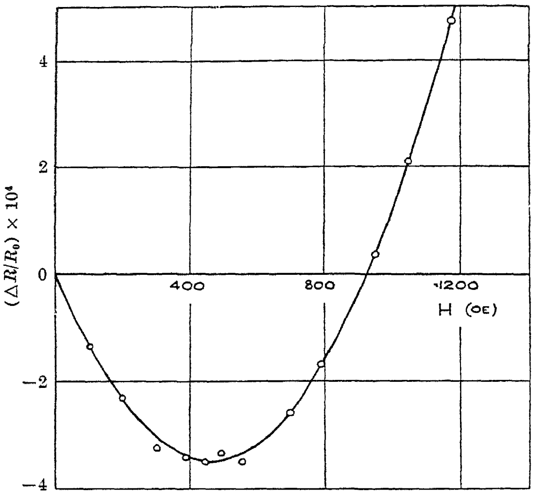

Fig. 2. Dependence of resistance on field-strength, illustrating the negative change

The anomalous change is quite small, and it will be seen that at the minimum of Fig. 2 it is of the order of 4 parts in 10^4. At first sight, a possible interpretation would appear to be in terms of a Hall E.M.F.; but the form of the specimens makes this unlikely and, moreover, the phenomenon does not appear with all fibres.

A negative change in resistance has been predicted on theoretical grounds by Meixner[3] for certain relative orientations of current, field and crystal axis. No previous experimental evidence is known to us, with the possible exception of a paper by Casimir and Gerritsen[4]. The latter, however, attribute their apparent *Umkehreffekt*, obtained with a single crystal, to the presence of a Hall E.M.F. In the case of our specimens, it would seem that while the direction of the current is normally parallel to the main cleavage plane, cases sometimes occur in which this is no longer the case.

A more detailed discussion will be presented elsewhere.

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April 20.

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Excited States of Silver Bromide and Iodide

IT appears that study of the absorption spectra of the silver halide vapours has, with the exception[1] of silver chloride, hitherto been confined to wavelengths above about 2500 A. We have recently photographed the absorption spectra of silver bromide and iodide in the range 2150–3000 A. with a Hilger medium quartz instrument. Within rather critical pressure limits, red-degraded absorption bands are observed in the region 2150–2475 A. for silver bromide and 2150–2350 A. for silver iodide.

For silver bromide, some forty bands have been assigned to a single system involving a transition between the ground-state[2] and an excited state with constants $\nu_e = 43{,}537{\cdot}4$, $\omega_e = 205{\cdot}0$, $x_e\omega_e = 0{\cdot}74$ cm.$^{-1}$. The vibrational constants refer to ^{109}Ag^{81}Br.

In the spectrum of silver iodide in this region, there appear to be two partly overlapping systems, resulting from transitions from the ground-state to two excited states :

C. $\nu_e = 44{,}717{\cdot}7, \omega_e = 158{\cdot}1, x_e\omega_e = 2{\cdot}3$ (for ^{107}AgI),
D. $\nu_e \sim 46{,}000$, $\omega_e \sim 165$ cm.$^{-1}$.

Thirty bands have been assigned to system $C \leftarrow N$, 17 to $D \leftarrow N$.

The products of dissociation cannot be determined unambiguously; but the most likely products are Ag(^2P) plus halogen (^2P) for all three excited levels.

The relations between the states of the silver halides are summarized below, where k_e is the force-constant in dyne/cm. × 10^{-5}, and ν_e is the system-origin in electron-volts. There seems to be little doubt that the new levels are analogous to the levels C and D of silver chloride.

State		AgCl	AgBr	AgI
D	ν_e	6·05	—	5·7
	k_e	1·3$_2$	—	0·9$_3$
C	ν_e	5·40	5·40	5·54
	k_e	1·318	1·149	0·85
B	ν_e	3·92	3·88	3·87
	k_e	1·226	0·894	0·521[3]
N	ν_e	0	0	0
	k_e	1·832	1·678	1·453

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The 'Renal Threshold'

According to the definition of Barclay *et al.*[1], the 'renal threshold' can be expressed as a rate of tubular reabsorption per 100 c.c. glomerular filtrate. Thus

$$T = 100 \frac{Rx}{C}, \tag{1}$$

where T is 'threshold', Rx is the amount of the 'threshold substance' reabsorbed by the tubules (mgm./min.), and C is clearance of inulin, or mannitol. The same conception of the 'threshold' is also used by Harrison *et al.*[2].

In 1945 I published with Szenes[3] a paper entitled "Aglucosuric Blood Sugar Concentration"[3,4]; this is a calculated blood sugar concentration, above which filtered glucose is not reabsorbed, but passes into the urine. This concentration is thus a dynamic 'threshold'; and the formula can, of course, be used not only in the case of glucose, but also in the case of any other 'threshold substance'.

We deduced the formula of such a threshold substance concentration as follows :

$$Ex = Fx - Rx, \tag{2}$$

where Ex is excreted substance (mgm./min.), Fx is filtered substance (mgm./min.).

$$\text{But } Ex = \frac{V.Ux}{100};\ Fx = \frac{C.Px}{100};\ Rx = \frac{C.Ax}{100};$$

where V is urine (c.c./min.), Ux is concentration of substance in urine (mgm. per cent), C is clearance of inulin, Px is concentration of substance in blood (mgm. per cent), and Ax is threshold (Szenes and Földi's formula).

$$\text{So } V.Ux = C.Px - C.Ax;\ Ax = Px - \frac{V.Ux}{C};$$

$$\text{but } C = \frac{U.V}{P},$$

where U and P are urinary and plasma inulin concentration (mgm. per cent) respectively.

$$\text{Hence } Ax = Px - \frac{P}{U}\,Ux. \tag{3}$$

The purpose of the present note is to determine the relation of our formula to Barclay's 'threshold'.

As I have pointed out above, Barclay's formula is :

$$T = 100\frac{Rx}{C}.$$

From equation (2) :

$$Rx = Fx - Ex.$$

$$\text{Hence } T = \frac{Fx - Ex}{C}\,.\,100 = \frac{C.Px - V.Ux}{C} = Px - \frac{V.Ux}{C} = Px - \frac{P}{U}\,.\,Ux.$$

Thus Barclay's 'threshold' and our formula are identical. This is noteworthy because we have deduced our formula by means of mathematical considerations, while Barclay chose his definition of the threshold because "plasma values are usually expressed to 100 c.c. and . . . 100 c.c. would appear to be fairly close to the more recent determination of the average rate of filtration in man".

From the equations

$$Rx = \frac{C.Ax}{100} \text{ and } Fx = \frac{C.Px}{100},$$

we have

$$\frac{Rx}{Fx} = \frac{Ax}{Px},$$

whence

$$Ax = Px\,.\,\frac{Rx}{Fx}. \tag{4}$$

This equation shows that the calculated concentration of the threshold substance in the blood is a function of the actual concentration, the rate of tubular reabsorption and glomerular filtration.

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April 12.

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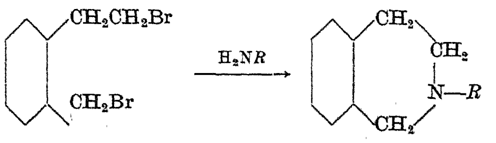
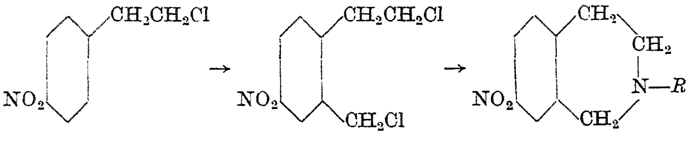
A New Synthesis of 2 : 7-Disubstituted-1 : 2 : 3 : 4-tetrahydro-*iso*-quinolines

It has been shown by Holliman and Mann[1] that *o*-2-bromoethyl-benzyl bromide (I) condenses readily with primary amines to give 2-substituted-1 : 2 : 3 : 4-tetrahydro-*iso*-quinolines (II). Although hitherto



I II

this has apparently been the only known method for the synthesis of 2-aryl-*iso*-quinolines of type (II), it has one serious disadvantage, namely, that for various reasons it does not lend itself to the preparation of *iso*-quinolines of this type having substituent groups in the benzene ring. The presence of such groups may be essential if the tetrahydro-*iso*-quinoline is to possess marked physiological action. To overcome this difficulty we have developed the following synthesis.



III IV V

2-Phenyl-ethyl chloride on nitration affords *p*-nitrophenyl-ethyl chloride[2] (III), which we find undergoes ready chloromethylation to the crystalline 5-nitro-2(2-chloroethyl)-benzyl chloride (IV). We have condensed this compound with several primary amines to obtain in each case the corresponding 7-nitro-2-aryl-1 : 2 : 3 : 4-tetrahydro-*iso*-quinoline (V). These *iso*-quinolines have in turn been converted to their 7-amino, 7-acetamido and other derivatives. The preparation of the dichloride (IV) is much simpler than that of the dibromide (I), and thus affords a ready route to these 7-substituted-*iso*-quinoline derivatives.

2-Phenyl-ethyl bromide can be similarly nitrated and then bromomethylated to form 5-nitro-2(2-bromoethyl)-benzyl bromide, which also readily gives the above cyclization with primary amines.

We are now investigating the synthesis of the phosphorus and arsenic analogues of compounds of type (V).

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Tryptochrome : a Pigment Derived from Tryptophan

WHEN 5 ml. of a very dilute (*c*. 0·05 per cent) solution of tryptophan in 60–80 per cent acetic acid is treated with a drop of 1 per cent aqueous potassium iodate, and warmed to boiling, a violet-pink colour develops, and an intense greenish-orange fluorescence. On dilution with two volumes of water, the pigment gradually separates, and can be extracted with *iso*butyl alcohol or with chloroform, in which solvent it shows a strong absorption band at λ 565–555 mμ, and a weak band at λ 520–515 mμ. Pigment formation requires a large excess of acetic acid, otherwise the mixture turns brown, and an iodotryptophan is precipitated, from which the pigment cannot be generated. The pigment is stable in acid solution, and both tint and fluorescence survive exposure to air and light for months.

The iodate can be replaced by hypochlorite bromate, or free bromine; but the pigment is less pure, and is very easily destroyed by a slight excess of the reagent. Chlorate, peroxide, persulphate, perborate, manganese dioxide, ferricyanide and ferric iron are ineffective for colour production.

The name 'tryptochrome' is suggested for the pigment, since it closely resembles, and may be identical with, the pigment formed in the well-known protein-ochrome reaction, obtained when tryptophan or a trypsin digest of protein is treated with bromine water, and extracted with amyl alcohol. The tryptochrome test will show free tryptophan in dilutions down to about 1 in 100,000. None of the other common amino-acids gives the reaction. On prolonged boiling with sufficient iodate, indole forms a mixture of pigments, including what appear to be indirubin and isatin ; but the conditions are much more drastic than those required for tryptochrome, and persulphate is more effective than iodate. Addition of iodate to a faintly acid solution of adrenaline leads to formation at room temperature of an iodoadrenochrome[1]. Under such conditions, tryptophan gives no colour. Adrenochrome closely resembles tryptochrome in tint, but neither it nor indirubin shows the orange fluorescence characteristic of tryptochrome.

Structure of tryptochrome. (1) Analysis of the product crystallized from a mixture of chloroform and light petroleum gives the percentage composition : C, 69·9 ; H, 4·6 ; N, 13·9, corresponding to the formula $C_{17}H_{14}O_2N_3$. (2) The reaction requires the free α-amino-group of the tryptophan. It is not given by unhydrolysed proteins, or by β-indolepropionic acid, or by tryptophan after treatment with nitrous acid or formaldehyde. (3) The reaction requires an unsubstituted α-carbon in the pyrrole ring. (4) Reduction in acetic acid by magnesium or zinc yields a leuco-product that gives no catechol reaction with molybdate or phenolic reaction with iron. The leuco-product slowly reoxidizes to tryptochrome on aeration. Hence it is concluded that tryptochrome, unlike adrenochrome, is not a quinone.

The evidence now obtained suggests that tryptochrome is an indirubinoid derivative.

The preparation and properties of tryptochrome are being investigated in the Chemical Department of this University by Mr. W. A. Boggust, aided by a grant from the Medical Research Council of Ireland. I am very grateful to Prof. Wesley Cocker for these facilities and for the interest he has taken in the work.

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Alkaline Phosphatase and Tumour Inhibition

IN the course of bioassays of extracts of normal male urine[1,2] for tumour-inhibiting properties, we have investigated their effect on alkaline phosphatase present in certain tumours by Gomori's histological technique. Similar examinations were carried out using other tumour-inhibitory substances, namely, stilbœstrol[3] and colchicine[4,5].

For the purpose of denoting the quantity of alkaline phosphatase in the tissues under investigation, we have used mouse kidney tissue as a comparative standard. All tissues, treated and untreated tumours and kidney, were incubated in the same jar and their further treatment carried out under identical conditions. Inbred albino mice were used as experimental animals.

(1) *Tumours investigated.* Transplants of Twort-mammary carcinoma, sarcoma and carcinoma induced by subcutaneous inoculation of crystallized methylcholanthrene, a transplant from the induced carcinoma, spontaneous mammary carcinoma in mice and their transplant. The Twort-mammary carcinoma shows a high concentration of alkaline phosphatase, so also do the transplants of the spontaneous mammary carcinoma in the first generation, but to a lesser degree. The other tumours referred to above contained little or no demonstrable alkaline phosphatase.

For the purpose of continuing our investigation Twort-mammary carcinoma were used.

(2) *Tumour-inhibiting substances.* (*a*) Toluene extract of urine and certain fractions thereof (possibly related to *H* 11), single dose 0·8 or 1·6 mgm. (*b*) Stilbœstrol, single dose 0·25 mgm. (*a*) and (*b*) were dissolved in 0·05 ml. of arachis oil and injected intraperitoneally twice a day on seven consecutive days. (*c*) Colchicine, 0·02 mgm. in 0·2 ml. of water, the mitoses arresting dose[5], given subcutaneously twice a day on three or five consecutive days. Mice were dissected when their body temperature dropped to 32·8° C. or less.

Untreated tumour-bearers or mice treated with arachis oil were used as controls.

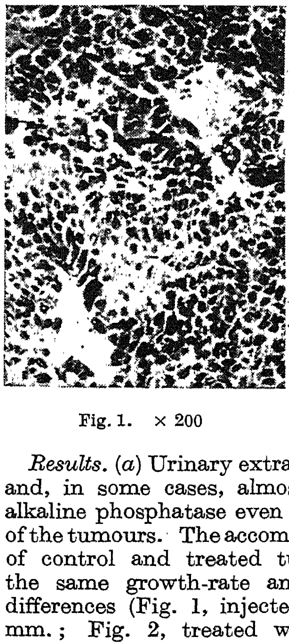

Fig. 1. × 200

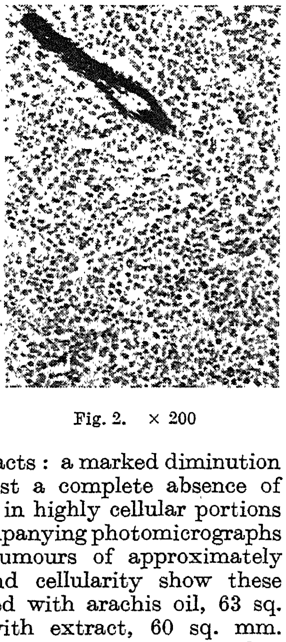

Fig. 2. × 200

Results. (*a*) Urinary extracts : a marked diminution and, in some cases, almost a complete absence of alkaline phosphatase even in highly cellular portions of the tumours. The accompanying photomicrographs of control and treated tumours of approximately the same growth-rate and cellularity show these differences (Fig. 1, injected with arachis oil, 63 sq. mm. ; Fig. 2, treated with extract, 60 sq. mm. surface area). It was our experience, however, that the amount of alkaline phosphatase demonstrable was approximately inversely proportional to the degree of inhibition of growth.

(*b*) Stilbœstrol : no diminution, but perhaps an increase in alkaline phosphatase. The adrenals of the treated mice, when compared to the controls, show a marked deposit of alkaline phosphatase in the subcapsular layers of the zona glomerulosa. This appearance may be of interest as it is claimed that regeneration of the adrenocortical cells commences in this area.

(*c*) Colchicine : alkaline phosphatase diminution due to cellular degeneration of tumours.

The cellular or other structure of each tumour was checked by hæmatoxylin-eosin staining of alternate sections.

It would appear that growth inhibitors present in normal male urine directly or indirectly reduce the alkaline phosphatase content of certain tumour cells.

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Effect of Sputum on Streptomycin

In a small series of seventeen cases of whooping cough treated with streptomycin, no beneficial effects were noted. The children receiving parenteral therapy, five hours after injection, had blood-levels of 2–12 units per ml. It was not possible to detect streptomycin in the blood of thirteen patients receiving aerosal therapy after 15, 30, 60 min. or 3 hr. The urine of these patients at no time during 24 hr. showed the presence of streptomycin.

Because of the inability to recover streptomycin after inhalation, *in vitro* tests were devised to observe the behaviour of streptomycin in the presence of lung extract, lung tissue, mucin and gastric juice ; the sources of these substances were sputum, 6 gm. of guinea pig lung ground in 10 c.c. nutrient broth, 10 per cent potassium hyaluronate and human resting-gastric juice, respectively.

Using the streptomycin assay technique devised by Mitchison, clear-cut results were obtained. The 10-mm. column of assay agar containing *Staph. mayo* was layered with the test material and the zone of growth inhibition of staphylococci was measured.

The mucin of the gastric juice, in contrast to the lung extract, potassium hyaluronate and sputum, allowed full activity of the streptomycin. Sputum was either shaken with streptomycin in a bottle containing glass beads before it was layered on a column of assay agar, or the sputum was layered on the medium and the streptomycin inoculated on top of the sputum. The potassium hyaluronate was shaken with streptomycin before being transferred into the assay tube.

By plotting the zone of growth inhibition in mm. against the logarithm of a known concentration of 2, 3, 4, 5, 10, 50 units streptomycin per ml., a graph was obtained from which the streptomycin content of inoculated material could be read. When layered on to the agar, before incubation, all mixtures were known to have a final concentration of 5 units streptomycin per ml. After 18-hr. incubation these mixtures were shown to contain less than one unit per ml.

Table 1 represents two experiments. The mean in mm. of inhibition and standard deviation of ten tubes for each group is recorded. Table 2 represents the mean and standard deviation of six tubes which were layered with sputum collected from a patient at 0, 3, 6, 9 hr. after having received an intramuscular injection of 1 gm. streptomycin. (Patient's blood

Table 1. Mean and standard deviation of zone of inhibition produced by :

	Sputum shaken with streptomycin	Sputum layered on agar, streptomycin superimposed	Potassium hyaluronate shaken with streptomycin	Streptomycin (10 units/ml.)	Streptomycin (5 units/ml.)
Exp. 1	2·1 ± 0·21	0·5 ± 0·71	2·38 ± 0·37	6·0 ± 0·16	4·7 ± 0·27
Exp. 2	2·9 ± 0·48	0·1 ± 0·32			4·9 ± 0·05

Table 2. Mean and standard deviation of zone of inhibition induced by sputum, before and after parenteral streptomycin

Hours	0	3	6	9	Control, streptomycin 5 units/ml.
	0·5 ± 0·71	0·4 ± 0·44	0·6 ± 0·52	0·6 ± 0·52	4·9 ± 0·05

5 hr. after receiving the streptomycin contained 7 units per ml.)

The differences between the three left-hand groups of Table 1 and either of the two right-hand groups, and the difference between the experimental groups and the control in Table 2 would have happened by chance much less than once in a thousand trials. This means that the difference between the means is highly significant.

The sputum, which was found to be alkaline, prevented the action of streptomycin either by a mechanical inhibitory action, or by a chemical inactivation, but not as a result of an acid reaction.

This observation helps to explain why organisms normally sensitive to streptomycin fail to be affected when embedded in sputum. The unsuccessful streptomycin trial in whooping cough may possibly be explained in this way. The disappointing results in the treatment of pulmonary tuberculosis can be understood, for on this basis tubercle bacilli, lying in sputum which has rendered the antibiotic sublethal, multiply and become resistant. The tubercle bacilli free in the spinal cord are destroyed, whereas those embedded in exudate at the base of the brain survive. When the tubercle bacilli lie on surface lesions such as ulcers of the larynx or vocal cords, the response to treatment is dramatic; but open phthisis is proving resistant to treatment.

Thanks are due to the Non-tuberculosis Streptomycin Trials Committee for the streptomycin and to Dr. B. Woolf and Miss E. Duncan for the statistical assay.

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Reconstruction of Laccase from its Protein and Copper

THE conception that oxidases are metallo-protein compounds in which the metal plays an essential part in the catalytic activity of the enzyme was introduced by Gabriel Bertrand[1] in the course of his studies on laccase, the oxidizing enzyme present in the latex of the Indo-Chinese lacquer tree. As crude preparations of laccase contained an appreciable amount of manganese, Bertrand assumed that this metal forms the active part of the oxidase. A more recent study of this problem by Keilin and Mann[2], based upon highly purified enzyme prepared on a large scale from the latex of different lacquer trees, produced evidence that the active metal is not manganese but copper. This view, however, was challenged by Didier Bertrand[3], who claimed to have isolated an enzyme of higher activity which contained 0·15 per cent manganese and only 0·014 per cent copper.

While studying the properties of laccase, an attempt was made to split the enzyme into its two constituent parts and to reconstruct it from its protein and a metal. The method used was that devised by Kubowitz[4] in the course of his study on the polyphenol oxidase of potato. The experiments were carried out as follows :

(1) The activity of the enzyme was tested in the Barcroft manometers. The following system was used: 10 mgm. pyrocatechol or hydroquinone, a suitable amount of laccase preparation, 0·1 *M* phosphate buffer *p*H 6·7 to a final volume of 3·3 ml. The manometer was shaken at about 160 cycles per min. and readings were made for the first six minutes.

(2) Enzyme preparations of activity (Q_{O_2}) varying from 3,000 to 18,000 in presence of pyrocatechol were obtained from the latex of the Indo-Chinese lacquer tree (*Rhus succedanea*) by fractional precipitations with alcohol and ammonium sulphate and by further purification with tricalcium phosphate gel.

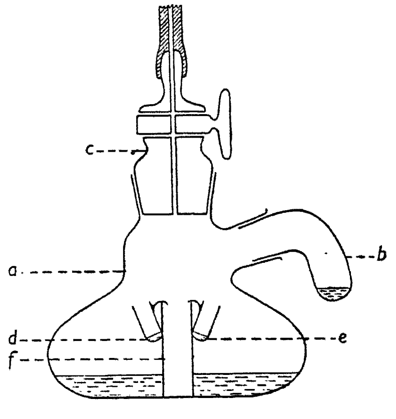

Fig. 1

(3) The splitting of the enzyme was performed in a modified flask of the Barcroft differential manometer (see Fig. 1). The flask (*a*) of about 30 ml. capacity has a side bulb (*b*) with a ground joint so that the contents of the bulb can easily be run into the flask by giving it a half-turn. The flask is provided with a stopper and tap (*c*) which can be connected with a vacuum pump and to a source of pure nitrogen. Two small dangling tubes (*d* and *e*) are suspended by means of platinum hooks from the lip of the central tube (*f*) fused to the bottom of the flask.

4 ml. of either crude or purified concentrated enzyme preparation and 1 ml. 0·5 *M* phosphate buffer *p*H 7·0 are placed in the flask *a*. The dangling tubes *d* and *e* receive 2 mgm. catechol and 3·2 mgm. ascorbic acid respectively and the side bulb *b* receives 0·03–0·05 ml. 2 *M* potassium cyanide in 0·05 *N* potassium hydroxide. After evacuating the flask and filling it with pure nitrogen, catechol and ascorbic acid are added to the enzyme by dislodging the dangling tubes, and then cyanide is added from the side bulb.

The mixture is left standing for 30 min. at room temperature. The flask is then opened and its contents are cooled to 0° C. and saturated with solid ammonium sulphate. The precipitated enzyme is centrifuged off and washed with 50 ml. of saturated ammonium sulphate containing 0·02 *M* potassium cyanide. The precipitate is dissolved in the minimum amount of water and dialysed for 12 hr. at 0° C. against 3 l. of 0·01 *M* phosphate buffer *p*H 7 and for a further 36 hours against 3 l. 0·005 *M* phosphate, which is changed three times.

The enzyme preparation thus obtained has almost completely lost its catalytic activity in the oxidation of catechol or hydroquinone.

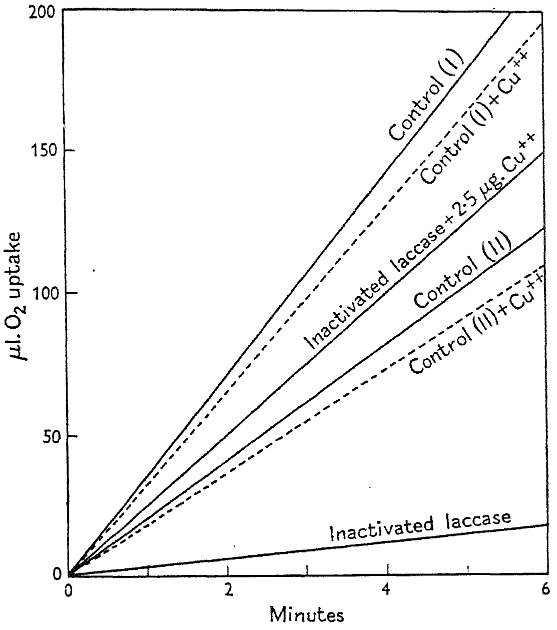

Fig. 2

(4) For the reactivation of this enzyme preparation, 2·5–12 µgm. of cupric, ferric or manganese ions are added (as cupric and ferric sulphates or manganese chloride) to 2 ml. samples of the inactivated enzyme preparation and left standing at room temperature for periods varying from 30 min. to 3 hr. The catalytic activities of these samples were then tested and compared with those of the untreated control samples (I) estimated at the beginning of the experiments, the control samples (II) treated only with ammonium sulphate and dialysed, and the samples inactivated by cyanide treatment. These experiments show that the activity of the cyanide-treated samples of laccase was not affected by the addition of either ferric or manganese ions, but was markedly increased by the addition of very small quantities of cupric ions. Fig. 2, which summarizes the results of the experiments with cupric ions, shows that the addition of 2·5 µgm. of this metal to the inactivated enzyme raised its activity to a level occupying an intermediate position between the controls I and II. That the activity of this reconstructed enzyme is somewhat higher than that of the control II is probably due to the fact that cyanide protected the protein of the inactivated enzyme from slow but irreversible changes which were proceeding in the control preparation II when it was submitted to precipitation and dialysis. It is important to note that the small concentration of cupric ions which strongly activated the cyanide-treated enzyme had no catalytic effect on the oxidation of either catechol or hydroquinone, and when added to the control enzyme preparations slightly inhibited their activities (Fig. 2).

These experiments clearly demonstrate that laccase is a copper-protein enzyme.

My thanks are due to Prof. D. Keilin, for his help and advice.

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Localization of Polyphenoloxidase in the Chloroplasts of *Beta vulgaris*

THE chloroplast as the seat of chlorophyll pigments in plants occupies a unique position in the economy of the green cell. In recent years there has been a renewed interest in the reactions and properties of chloroplasts as a result of the work of Hill[1,2] and Hill and Scarisbrick[3,4], who demonstrated that the reaction characteristic of photosynthesis in green plants, the evolution of oxygen, occurs in appreciable quantities in isolated chloroplasts under the influence of light and in the presence of suitable oxidants.

In the course of an investigation of oxygen evolution by isolated chloroplasts, it was deemed important to explore their enzymatic composition. Of special interest were considered enzymes capable of participating in oxidation-reduction reactions and, more particularly, those localized principally, if not entirely, in the chloroplasts. This communication presents evidence that a copper enzyme, polyphenoloxidase (otherwise known as tyrosinase or catecholase), is localized in the chloroplasts of spinach beet (chard), *Beta vulgaris*.

In a preliminary experiment, it was found that the addition of catechol to a crude leaf extract of spinach beet leaves was followed by a rapid uptake of oxygen. This suggested the presence of a polyphenoloxidase in the leaves, and it became of interest to determine whether the enzyme is found in the chloroplasts or in the cytoplasmic fluid obtained after the separation of chloroplasts and their fragments.

Leaves of plants grown in sand cultures were mashed in a Waring blender and the green extract fractionated by high-speed centrifugation (approximately 25,000 *g*) into a suspension of chloroplast fragments and a 'cytoplasmic fluid' practically free of chlorophyll.

Polyphenoloxidase activity of the two fractions was tested by using catalytic amounts of catechol with ascorbic acid as a substrate[6]. Consistent with the well-established[6,7] copper-protein nature of polyphenoloxidase, the activity of this enzyme in the chloroplasts was inhibited with cyanide and carbon monoxide. The carbon monoxide inhibition was insensitive to light[5]. The enzyme was also inhibited by more specific copper poisons such as sodium diethyldithiocarbamate[8].

The procedures used for disintegrating leaves were necessarily drastic and resulted in disruption of cytoplasmic bodies, including the chloroplasts. The possibility was therefore considered that the localization of polyphenoloxidase activity in the chloroplasts could be attributed to preparatory technique. On *a priori* grounds this was considered unlikely: the enzyme persisted in the chloroplast fragments and was absent from the cytoplasmic fluid, into which it would be expected to pass in case of disruption of the chloroplasts. Nevertheless, experiments were carried out with the experimental procedures modified in several respects, giving special attention to differences in technique which might have accounted for such divergent reports as were found in the literature.

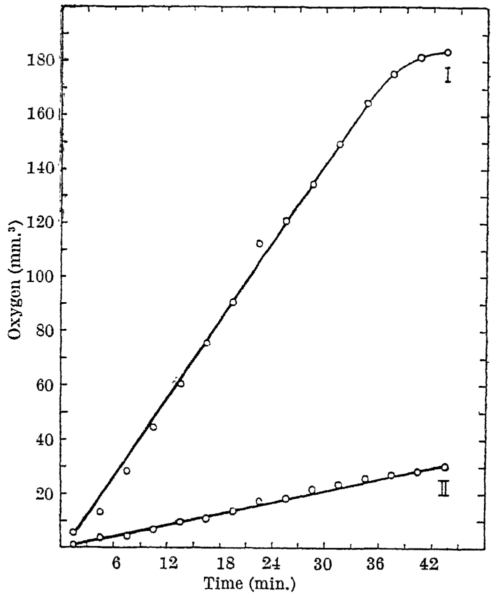
First, the possibility was considered that if the enzyme were originally present in the cytoplasmic fluid, then the high-speed centrifugation used for separating the chloroplast fragments might have sedimented the enzyme as well. This point was tested by adding a crude potato polyphenoloxidase to the leaf mash prior to the high-speed centrifugation. Upon subsequent fractionation of the mash into chloroplast fragments and cytoplasmic fluid, the added potato polyphenoloxidase was recovered in the cytoplasmic fluid. The polyphenoloxidase activity of the chloroplast suspension was not enhanced.

Warburg and Lüttgens[9], working with similar preparations from spinach and sugar beets, attributed about a quarter of the polyphenoloxidase activity of the crude green leaf extract made at *p*H 6·5 to chloroplast suspensions and the remaining three-quarters to the cytoplasmic fluid. These authors considered the *p*H of the extract important. At an acid reaction, at *p*H 5 for example, they found that a major portion of the cytoplasmic polyphenoloxidase was precipitated and in a subsequent centrifugation was recovered with the chloroplast fragments.

Although the preparations used in this investigation were uniformly made at *p*H 6·5, it was undertaken to test the effect of hydrogen ion concentration on the distribution of polyphenoloxidase by extracting the chloroplast suspension at the more alkaline *p*H 7·3. The results indicated that, as with other preparations, the polyphenoloxidase activity of leaf extracts made at *p*H 7·3 was also localized in the chloroplasts.

Bonner and Wildman[10] studied the respiration of spinach leaves and concluded that polyphenoloxidase is their terminal oxidase. Unlike the present findings, however, these authors reported the presence of polyphenoloxidase as confined to the cytoplasm rather than to the chloroplasts. The technique used by Wildman and Bonner[11] involved grinding the chloroplasts in a Charlotte colloid mill, with resultant disintegration of chloroplasts into chlorophyll-containing granules and non-chlorophyllous 'stroma'. These authors[11] are aware that their conclusions as to the distribution of enzymes between chloroplasts and cytoplasm can be properly interpreted only with reference to their own manipulative technique. It was already noted that in the same plant, spinach, Warburg and Lüttgens[9] found polyphenoloxidase both in chloroplast fragments and in cytoplasm. The spinach beet used in the present investigation is a chenopodiaceous plant related to sugar beet and spinach.

It seemed desirable, in view of the results of Bonner and Wildman[10], to subject the already disrupted chloroplasts comprising the chloroplast suspensions used in this investigation to further disintegration. This was done by grinding the green leaf extracts with glass beads for 10 min. in a Mickle tissue-disintegrating machine, prior to the high-speed centrifugation. A microscopic examination of the ground chloroplast suspension disclosed uniform round particles more than 1 millimicron in diameter. This further subdivision of the chloroplast fragments failed to dislodge the polyphenoloxidase. As before, the enzyme was found in the chloroplast suspension rather than in the cytoplasmic fluid. The results are presented in the accompanying graph.



Polyphenoloxidase activity of chloroplast fragments and cytoplasmic fluid of spinach beet. Curve I: disintegrated chloroplast suspension containing 0·8 mgm. of chlorophyll. Curve II: cytoplasmic fluid containing 0·02 mgm. chlorophyll, after removal of disintegrated chloroplasts. Reaction mixture contained 2·4 mgm. ascorbic acid and 0·02 mgm. catechol in $M/15$ potassium phosphate buffer (*p*H 6·5). Temperature of bath, 20° C.

The localization of a copper-protein oxidase in cellular bodies so intimately identified with the process of photosynthesis raises at once the question of the possible participation of this enzyme, directly or indirectly, with one or more of the biochemical reactions which are linked with the process of photosynthesis in those green plants which contain polyphenoloxidase[12]. The answer to this question must await further experimentation.

A full account of these experiments will be published elsewhere.

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DEFINITIONS OF BOND-ENERGY IN PHYSICAL CHEMISTRY

THE expression 'bond-energy' continues to be used in at least two senses: (*a*) for the *mean* contribution from each bond of a given type to the total heat, $-\Delta H$, of formation of the molecule from its constituent atoms; (*b*) for the energy, ΔH, required to disrupt the molecule at a particular bond into two fragments.

As was first pointed out by Fajans[1], and later developed by Sidgwick and Pauling, the 'bond-energy', usage (*a*), of a given bond $X—Y$, shows a remarkable degree of constancy over a wide range of compounds, provided that the valency of neither X nor Y alters. But the 'bond-energy', usage (*b*), may vary markedly with the molecular environment of the bond. Despite frequent warnings[2], confusion between these two interpretations of 'bond-energy' still exists, and it seems to us desirable that the simple but ambiguous expression 'bond-energy' should be abandoned in favour of two separate expressions specific for the usages (*a*) and (*b*).

For usage (*a*), the expression 'mean bond-energy term' has already been proposed[3]. We would further suggest the use of the symbol $E(X—Y)$ to denote this quantity. The relation between $E(X—Y)$ and the thermochemical data for a molecule XY_n is given by

$$n\,E(X—Y) = -\Delta H_{298}$$

for the reaction

$$X_{(g)} + nY_{(g)} \rightarrow XY_{n(g)},$$

that is, the heat of formation of the gaseous compound from the free atoms of its constituent elements, the 'atomic heat of formation'. We suggest the use of a superscript a in discussing enthalpy terms for reactions in which the initial state of the system is that of free atoms, and we follow Bichowsky and Rossini[4] in using Q for $(-\Delta H_{298})$. The particular $-\Delta H_{298}$ term in question, above, has then the symbol $Qf^{a}{}_{(g)}$, which, if considered too cumbersome, might be modified to Q_a. For the heat of formation of the gaseous compound from its elements *in their standard states*, we suggest the symbol $Qf^{s}{}_{(g)}$, while for the $-\Delta H_{298}$ for the formation reaction in which both the set of initial elements and the final compound are all in their standard states, the symbol Qf^{0} follows from the universally accepted convention of Lewis and Randall[5].

For the usage (*b*), we would suggest the expression 'bond dissociation energy' and the symbol D together with a specification of the particular bond; for example, $D(XY_{n-1}—Y)$. In the case of polyatomic molecules there is not necessarily an identity between the quantities $E(X—Y)$ and the individual $D(X—Y)$ values, the only connexion being that, for a given molecule, the sum of all the E terms shall equal the sum of the D values for each stage in the stepwise dissociation of the molecule into free atoms.

In constructing tables of mean bond-energy terms, Sidgwick and Pauling adopted the convention of measuring the atomic heats of formation with respect to ground-state atoms. Recently, Long and Norrish[6] have expressed the view that in dealing with compounds of tetravalent carbon, the E values for carbon bonds should be assessed, not from the $s^2p^2\ {}^3P$ ground-state but from the $sp^3\ {}^5S$ excited state. They urge this on the grounds that molecules such as CH_4 (for example) are built up from the tetravalent ${}^5S$ carbon atom and not from the divalent ${}^3P$ ground-state. This change in the zero from which the total energy content is to be measured should be correspondingly reflected in the symbols used; for example, by using Qf^{a*} in place of Qf^{a}, and E^* in place of E. In this connexion we are unable to agree with the statement of Long and Norrish[6b] that Pauling's table of mean bond-energy terms "contains values deficient in the case of links involving carbon", for Pauling's E values are no less true in respect of his definition of a mean bond-energy term than are the E^* values of Long and Norrish, which are based on a different definition.

If one adopts consistently the point of view that in the specific case of tetravalent carbon compounds E^* terms are preferable to, or more significant than, E terms (because of the building up of such compounds from $C({}^5S)$), one must recognize the necessity of discarding E terms in favour of E^* terms for a large number of bonds other than those involving carbon. An example is provided by the beryllium hydride molecule BeH, which, although dissociating to give a ground-state ${}^1S$ beryllium atom, would be considered as built up from the excited ${}^3P$ state; similarly with the sodium chloride molecule NaCl, since this 'derives' essentially from the ion-pair $Na^+\ Cl^-$, despite its dissociation into ground-state atoms. These two examples are relatively simple ones; in others, for example, hydrogen fluoride, HF, it is rather difficult to identify the atomic species from which the molecule is built up. In general, it seems to us that the Pauling convention leads to mean bond-energy terms in a more simple and less ambiguous manner than would result from a consistent application to all compounds of the convention used by Long and Norrish in respect of carbon compounds.

In connexion with their view that, in tetravalent carbon compounds, E^* values are more significant than E values, Long and Norrish make the specific point that it is reasonable to correlate E^* (C—H) in CH_4 with $D(CH_3—H)$, whereas a correlation with E (C—H) would be meaningless. They develop from this point an attack on the problem of deciding between the two spectroscopically permissible values for 'L_1', the ΔH_0 for the reaction

$$C_{\text{graphite}} \rightarrow C({}^3P)_{(g)}.$$

Their numerical correlation of E^* (C—H) in CH_4 with $D(CH_3—H)$ leads them to conclude that $(L_1 + x) \sim 190$ kcal./gm. atom, where x is the excitation energy, ΔH_0, for the atomic transition $C(s^2p^2,\ {}^3P) \rightarrow C(sp^3\ {}^5S)$. Recently, Shenstone[7], by experimental observation, has given the value of x as 96·4 kcal./gm. atom. This throws some doubt on the assessment of $(L_1 + x) \sim 190$ kcal., since such a value would imply that L_1 is less than 100 kcal. The assessment of $(L_1 + x) \sim 190$ kcal. is based on two assumptions: (i) that the bonds in the $\cdot CH_3$ radical are roughly equivalent in strength to those in CH_4 (that is, the 'energy of reorganisation' of the $\cdot CH_3$ radical is small), and (ii) that the tetracovalent state of the carbon atom in CH_4 is identical with the ${}^5S$ state of the free carbon. But, with regard to (i), since we cannot either describe with certainty the character of the C—H bonds in the $\cdot CH_3$ radical (sp^3 or sp^2 bonding ?), or make due allowance for the interaction between non-bonded hydrogen atoms in $\cdot CH_3$ or CH_4, the reorganisation energy cannot be simply estimated, and might be quite different from the value chosen by Long and Norrish; and in respect of (ii) Van Vleck[8], in a detailed discussion of this specific point in 1934, concluded that the 'valence-state' cannot be identified with any one of the six atomic states of the carbon atom corresponding to the configuration sp^3, but is rather to be considered as a linear combination of all six levels (Van Vleck computed that the 'valence-state' lies *c.* 164 kcal. above the ^3P ground-state). Accordingly, although we recognize the power of the argument of Long and Norrish regarding the assessment of L_1, we are unable to accept it as conclusive, and are generally of the opinion that further direct experimental work, probably on the dissociation of CO or CN or on the later stages of the stepwise dissociation of CH_4, is necessary to settle this important problem.

Note added in proof.—In connexion with the final sentence of our note, we would direct attention to the new direct measurement of L_1 by Brewer, Gilles and Jenkins[9] referred to by Pitzer[10]. They obtain the value 170·39 ± 0·20 kcal. for L_1 at 0° K.

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I am very grateful to the courtesy of the authors of the foregoing letter and the Editors of *Nature* for the opportunity of appending a reply to the criticisms involved.

In the previous paper with Prof. Norrish[1], the remark that Pauling's listed values of bond-energies contain values which are deficient for links involving carbon is consistent with the fact that Pauling, in his section on the energies of covalent bonds[2], describes the covalent bond by a wave function in which the coefficients of the various ψ values are such that make the bond-energy a maximum. Having thus introduced the concept of bond-energy, Pauling, in comparing thermochemical bond-energies, naturally makes no attempt to divorce their meaning from the wave-mechanical representation, which, on the contrary, would seem to be required by the above definition of Skinner and Springall in the case of compounds of tetravalent carbon. In this connexion, it has frequently been pointed out[3] that the carbon atoms must have the sp^3 configuration to provide the appropriate wave functions. Accordingly, the low values of the carbon bond-energies calculated thermochemically from the ground s^2p^2 state are deficient according to Pauling's *usage*, since they bear to the required values no closer relation than the fivepence change bears to the cost of a sevenpenny article for which a shilling has been paid. The two usages are not, in our opinion, based on different definitions, the example quoted by Pauling by way of definition being identical with our manner of definition.

It is true that the same principle must be applied to a large number of bonds other than those involving carbon. Cases in point are the boron trihalides, which require the unpairing of the *s* electrons on the boron atom and its promotion to the sp^2 configuration. For co-ordinate links to oxygen, on the other hand, as in the amine oxides and oxyacids of chlorine, for example, the question is one of pairing the two unpaired electrons on the oxygen atom, that is, bringing it from a triplet to a singlet state. None of the examples quoted by Skinner and Springall involving varying degrees of bond polarity create any more difficulty to the one point of view than to the other so far as covalent links are concerned, and it is difficult to see their relevance to the discussion. For heteropolar molecules such as Na^+Cl^-, the bond-energy is not to be confused with the ionic attraction, which is related to the dissociation energy by an algebraic function of the ionization energy of the metal atom and the electron affinity of the non-metal atom. In cases such as the BeH molecule, the relevant atomic states required to give a stable molecular orbital are not normally in doubt, even though the dissociation scheme may involve the avoidance of crossed potential energy curves. It is the contention of this note that an application of the principles of electron-pairing to the selection of atomic terms for the derivation of bond-energies does not in itself lead to ambiguity, and that failure to apply these principles has on occasions led to erroneous conclusions, as pointed out previously[1,4].

It is not a fair statement of the facts to say that we assumed the bonds in CH_3 and CH_4 to be roughly equivalent in strength, since these strengths are interrelated with L_2, for which limits were derived in our paper. It likewise follows from these limits that the reorganisation energy of CH_3 on its formation from CH_4 is small. It may need to be pointed out here that, according to the initial definition we gave[1] for the bond-energy E, the energy of reorganisation calculated from experimental data is a *net* effect which includes the effects due to any possible change in the bonding to sp^2 and repulsion between the hydrogen atoms (as well as all other secondary effects within the molecule such as that due to delocalization of the bonding electrons[3]), so that the remarks of Skinner and Springall concerning these factors are beside the point and do not apply here. The same conclusions also follow from the original definition of energy of reorganisation[5]:

$$\begin{matrix}\text{energy of}\\ \text{linkage}\end{matrix} = \begin{matrix}\text{energy of}\\ \text{dissociation}\end{matrix} + \begin{matrix}\text{energy of}\\ \text{reorganisation}\end{matrix}.$$

It is, of course, possible to define bond-energies in such a way that all these effects are separated out, but we adopted the more usual convention of including them.

The remaining point concerning the 'valence-state' of carbon as calculated by Van Vleck[6] is also one of convention. Adopting Van Vleck's convention, it is necessary for the sake of consistency to calculate bond-energies from the 'valence-states' of all other atoms (which in the case of oxygen and nitrogen, for example, are *not* the ^3P and ^4S states respectively), the energies of some of these states having also been calculated[7]. On this basis, the criticism put forward by Skinner and Springall conflicts with their own definitions laid down at the outset of their communication. Again, we adopted the usual convention of referring bond-energies to atomic states. The identification of the tetravalent state of carbon with the ^5S level seemed at the time, in the absence of a spectroscopic value, to be confirmed by the calculations of Ufford[8] and experimental data concerning the CN radical[1]. The discrepancy with the recent observations of Shenstone[9] will be dealt with in a future communication. It is in no sense responsible for the discrepancy between our conclusions and those of Springall[10] concerning the heat of atomization of carbon, this being due to entirely different reasons which are discussed in a forthcoming paper.

In conclusion, it seems to me that the expression 'mean bond-energy term' is an unfortunate choice. As originally employed for polyatomic molecules by Butler and Polanyi[11], a constancy in energy is assumed for any one kind of link from molecule to molecule, differences in the dissociation energies being attributed entirely to resonance energy of the resulting radicals. This point of view ignores changes in the energy of unruptured links during a dissociation process, whereas the statement that bond-energies according to Skinner and Springall's usage (*a*) show "a remarkable degree of constancy" seems difficult to maintain in the face of much experimental evidence. If this were so, then every process of the type

$$CH_4 + CO_2 \rightarrow 2H_2CO,$$

in which the number of each type of bond remains the same, would be thermoneutral, whereas this is far from being the case. The example quoted is endothermic to the extent of about 60 kcal., which must be attributed to changes in the energies of the C—H or C=O bonds or, more probably, both. The extent to which the bond-energies (as distinct from the dissociation energies) of C—H, C=O and many other bonds do, in fact, vary has received frequent consideration in the literature[12].

L. H. LONG

University College,
Exeter.

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[3] See, for example, Coulson, C. A., *Quart. Rev. Chem. Soc.*, **1**, 144 (1947).

[4] Long, L. H., and Norrish, R. G. W., *Nature*, **158**, 486 (1946).

[5] See the discussion to the paper by Norrish, R. G. W., *Trans. Farad. Soc.*, **30**, 103 (1934).

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[11] Butler, E. T., and Polanyi, M., *Trans. Farad. Soc.*, **39**, 19 (1943).

[12] See, for example, the discussions and references given by Walsh, A. D., *Trans. Farad. Soc.*, **43**, 60 (1947); *J. Chem. Soc.*, 398 (1948).

GERMAN MOTOR ROADS

BEFORE the War much interest was taken in Great Britain in the German *Autobahnen*. Their design and construction were well described then in both the technical and popular press. The system is the only modern road network planned on a national scale and is worthy of most careful study in order that practice in Britain and elsewhere may profit as much as possible from German experience. The recent B.I.O.S. Overall Report*, entitled "German Motor Roads, 1946", is therefore particularly valuable in that it gives comprehensive information on the present state of these roads. The report, which contains thirty-nine excellent plates, is clearly and succinctly written and can be strongly recommended to the general reader.

The roads have been laid out on new ground, independently of existing roads, so as to link the main cities and industrial areas. The great extent of the system is emphasized by the fact that although a length of some 2,380 miles of dual-carriageway road is already in service, only about one half of the length originally planned has been completed. One of the chief impressions gained by the observers was of the high quality maintained throughout rather than of any exceptional excellence in particular sections, which were nowhere better than has been achieved elsewhere. This consistency is attributed to the policy of working to a single standard determined centrally, and of employing contractors carefully selected for their ability to undertake work of such a magnitude. The designs of the later roads were modified in the light of the experience gained from those already in service.

An admirable feature is the absence of extensive cracking of the concrete surfaces; this has been achieved by building on a gravel foundation, the material being imported if it was not already available locally. The elaborate plans adopted at crossings and road junctions to avoid the conflict of traffic lanes are well known; when adequately signposted, these are not found to be confusing. Another striking feature is the design of bridges; a great variety of construction has been used to suit local conditions and the workmanship is described as being of outstanding merit. Fifteen photographs in the report give a good idea of the lightness of effect achieved in over-bridges and of the pleasing design of the under-bridges; the latter carry the roads across valleys and are often larger than are met with in common practice owing to the stringent gradient restrictions which were maintained. Care has also been taken to blend the roads into the landscape by careful location, by rounding the slopes of cuttings and embankments, and by the method of planting adopted.

The report finally concludes that "the lay-out and alignment of the German motor roads are of a sufficiently high standard to suggest a degree of safety and sense of security above that obtained on ordinary main roads in Britain". Undoubtedly we can learn much not only from the felicities of this great experiment but also from its defects, a number of which are recorded and illustrated. R. H. MACMILLAN

* British Intelligence Objectives Sub-committee Overall Report No. 5. (H.M. Stationery Office, 1948.) 1*s*. 6*d*. net.

CONSTITUTION OF THE PLANETS

MORE than thirty pages of the first part for this year of the Monthly Notices of the Royal Astronomical Society are devoted to "Reports on the Progress of Astronomy", under which is included "The Constitution of the Planets", "Solar Activity", "Comets" and "Double Stars". By far the longest of these is the first, and it is possible to glance at only a few of the points dealt with by Rupert Wildt.

Quite recently our view that satellites could not retain atmospheres has been shown to be incorrect, as methane absorption has been discovered in the spectrum of Titan. The atmosphere of Titan, which is stable under present conditions, would have its stability endangered if its temperature were raised by only 100° C. Hence, if the evolution of the satellite passed through a stage of high surface temperature—as is believed to have happened with all the members of the solar system—the atmosphere of Titan must have been formed subsequent to that period. Kuiper believes that the same argument applies, with almost equal force, to Mars and perhaps to Venus and the earth also. He points out that the existence of methane on Titan suggests a genetic relation to its primary or to the other giant planets, and shows that the satellite cannot be the product of capture from an elliptical orbit extending into the interior region of the solar system.

At the end of the review it is pointed out that there are four different groups of phenomena which are worthy of some attention as possible clues to the history of the solar system. These are: (1) The correlation between the mass of a planet and the size and composition of its atmosphere-oxides on the terrestrial planets and hydrides on the giant planets. (2) The existence in Saturn's system of two types of satellites with densities greater than that of rock and less than that of water. (3) The nature and origin of the envelopes of low density characteristic of all the giant planets. The theory of Kuhn and Rittmann rules out the possibility of gravitational separation leading to the formation of a heavy core and more especially in the giant planets; and if their view should be accepted, the marked concentration of density towards the centre of the giant planets would favour the accretion theory of planetary formation. (4) The mean chemical composition of the planets in relation to the composition of the sun. As it is possible to explain the scarcity of light elements on the terrestrial planets by dissipation, no further cosmogonic inferences can be made so far as this is concerned. Of course, if the planetary matrix were much richer in lighter elements than the bulk of the sun, some doubts would be thrown on the formation of the planets by sudden ejection from the sun, which would have been accomplished by an unavoidable loss of hydrogen. When more accurate values for the mean composition of the sun and giant planets are available, they may facilitate a choice between the rival theories of the origin of the solar system, through a sudden catastrophe with subsequent rapid condensation, or through gradual accretion.

OSLER AS A SCIENTIST*

By Sir ARTHUR MacNALTY, K.C.B.

SIR WILLIAM OSLER is famous for many things. He was a great physician of two continents, a scholar, a humanist, a teacher and a medical administrator. His work as a scientist has perhaps received less recognition, yet it is revealed on every page of his famous text-book of medicine. As Harvey Cushing wrote[1]: "The volume, indeed, was what might be called a practical pathology in which were given the results of modern investigation, microscopical, bacteriological, and chemical. On this foundation was built up the symptomatology and diagnosis of disease. . . ." His school-master, the Rev. W. A. Johnson, at Weston, near Toronto, introduced him to the study of biology, geology and the use of the microscope. At eighteen years of age, Osler began to tabulate and study his collection of the Diatomaceæ; and his interest in biology was stimulated further, when he entered the Toronto Medical School in 1868, by Dr. James Bovell. "I am at Dr. Bovell's every Saturday and we put up preparations for the microscope," he writes.

His first publication was a short sketch entitled "Christmas and the Microscope" (*Hardwicke's Science-Gossip*, London, Feb. 1, 1869), in which he describes the diatoms and Infusoria he identified in a bottle of water. In 1870 he presented to the Natural History Society of Montreal the results of his studies on the Diatomaceæ of Canada, enumerating 109 species under twenty-nine genera and describing the structure, mode of division and propagation of the diatom[2]. In 1877 he read a paper before this Society on Canadian fresh-water Polyzoa[3] and published a supplementary note on this paper in the *Canadian Naturalist*, 1881 [4]. He mentioned a species of *Cristatella* as having been found in abundance and described a new species of *Pectinatella*.

In 1872–73 Osler had spent fifteen months in the Physiology Laboratory, University College, London, working at physiology and histology under Prof. Burdon-Sanderson. While there he was offered the chair of botany in McGill University; but declined it as insufficiently qualified for the post. At University College he began working "On the Action of certain Reagents—Atropia, Physostigma and Curare—on the Colourless Blood-Corpuscles"[5]. The published results were negative. In 1873 he made his most important contribution to scientific knowledge by investigating with Edward Schäfer the form and movement of the blood platelets. Though a few previous workers, for example, Bizzozero and Hayem, had observed these bodies, "the third element of the blood", it was Osler who saw them first in the circulating blood and carefully described them, and his observations were presented before the Royal Society by Burdon-Sanderson in 1874[6]. Afterwards, he published several papers and lectures on the blood, including one on the development of blood corpuscles in the bone-marrow[7]. All this work established Osler's reputation as an original investigator.

Returning to Montreal in 1874 as lecturer of Institutes of Medicine, he studied the 'entozoa', and R. Ramsay Wright, professor of biology at Toronto, named a trematode worm, which Osler had found in the gills of a newt, *Sphryanura Osleri*[8]. Osler, as professor of physiology in the Veterinary College, Montreal, and vice-president of the Montreal Veterinary Medical Association, also worked at comparative pathology, being one of the first to realize its importance in relation to medicine. He published several papers on this subject during the next few years. In the first of them, on a form of bronchopneumonia in dogs, he described a previously unknown parasitic nematode as the causal agent[9]. This organism was afterwards renamed *Filaria Osleri* by Cobbold in 1879. The most important of the other papers dealt with hog cholera[10], echinococcus[11], cestode tuberculosis[12] and the parasites in the Montreal pork supply[13]. As a by-product of this latter investigation he took up the subject of trichinosis and echinococcus infections in man. He studied the parasites in the blood of the frog, demonstrating and classifying *Rana mugiens*, the *Trypanosoma Sanguinis* (Grubby) and the *Drepanidium ranarum* (Lankester)[14].

Osler confirmed Koch's discovery of the tubercle bacillus as the cause of tuberculosis in 1882; but he never became an adept in bacteriological technique. Harvey Cushing, his biographer, considered that at first he inclined towards Bastian's belief in spontaneous generation, and by the time that Pasteur's views had been accepted, he had abandoned experimental medicine and comparative pathology for the clinical study of disease. The call to Philadelphia to be professor of clinical medicine in the University of Pennsylvania in 1884 marks the end of Osler's investigations as a pure scientist in the fields of zoology and physiology. In these fields he had achieved reputation as a trained microscopist and had made important contributions to knowledge. As W. T. Councilman said: "He could easily have become a great scientist, but he chose the path which led to the formation of the great clinician which he became; a worthy associate of the great men who have made English medicine famous"[15].

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* A paper read to the Osler Club on July 12.

Already at Montreal Osler had used the microscope in his pathological studies and continued to promote pathological research in association with clinical investigation in the Philadelphia and Baltimore periods. Thus his Goulstonian Lectures on malignant endocarditis[16], based entirely on autopsies performed in Montreal, contained the first comprehensive account in English of the disease and are largely clinical and pathological, but not experimental. He suggested that malignant endocarditis was invariably of bacterial origin; he stained the organisms in the tissues and made a few inconclusive inoculation experiments; but left to others the task of bacteriological investigation of this malady.

One of Osler's last pieces of microscopical investigation was his confirmation in 1886 of Laveran's discovery of the malarial parasite[17]. It was due to Osler's prompt appreciation of this discovery that the prevalent theory of a mysterious nocturnal 'miasma' was overthrown in the United States, and in his Baltimore Clinic, a few years later, he insisted that no diagnosis of malaria should be made without a microscopic examination of the blood. His hæmatological studies led him to take a special interest in diseases of the blood, and he described in 1902 "cyanosis with polycythæmia"[18], since known as 'Osler's disease'. A hereditary malady characterized by multiple telangiectases associated with hæmorrhages[19] is also styled 'Osler's disease'.

Throughout his professional life, William Osler applied his scientific knowledge to the study of clinical disease and brought the laboratory to the bedside. His teaching in this respect has greatly influenced the progress of clinical medicine. He referred to this guiding star of his work in the following words: "To the physician particularly a scientific discipline is an incalculable gift which leavens his whole life, giving exactness to habits of thought and tempering the mind with that judicious faculty of distrust which can alone, amid the uncertainties of practice, make him wise unto salvation"[20].

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SCIENCE OF THE AMARYLLIDS

THE American Plant Life Society, organised for the increase and diffusion of knowledge concerning plant-life, issues the year-book "Herbertia", which is devoted to the Amaryllids. Issues for 1946 and 1947 appeared together late in 1947 (from the Society, Box 2398, Stanford, California), and contain some useful papers of scientific interest. A detailed account of "the karyo-systematics of the sub-genus *Ajax* of the genus *Narcissus*" (Vol. 13, 1946) is contributed by A. Fernandes and Rosette Fernandes of Portugal. Of about eighteen species, fourteen are diploids, normally with $n = 7$. *Narcissus hispanicus* is constituted of diploid and triploid forms, *N. tortuosus* is triploid, and *N. bicolor* tetraploid. Fifteen somatic chromosomes are found in *N. asturiensis*, *N. minor*, *N. pumilus* and *N. pallidiflorus*. Since all the species have the same karyotype, this supports the idea of Baker (1888) that the group is a single, very polymorphic Linnean species. The different forms have arisen by gene mutation and polyploidy.

A useful description of narcissus disease symptoms and control is given by Charles J. Gould (Vol. 13, 1946), with several photographs. Perhaps the most interesting to British readers is a virus disease rather appropriately named 'decline', but also known as 'white streak'. A corresponding paper on insect and mite pests of narcissus by E. P. Breakey mentions the narcissus bulb fly, the lesser bulb fly and bulb mites, all of which are already known in Great Britain. It is usual to grow Amaryllids for their garden beauty, but M. J. Cox and M. M. MacMasters show (Vol. 14, 1947) that starch can also be prepared from the tuberous roots of *Alstrœmeria aurantiaca* and *A. chilensis*. Granules from the former are simple, but those from the latter have an unusual compound nature. Both give pastes which have similar characteristics to other root starches.

There are also shorter articles on all aspects of Amaryllid culture, breeding and classification.

JOHN INNES HORTICULTURAL INSTITUTION

FOR thirty-eight years, the John Innes Horticultural Institution has been carrying out detailed investigations in plant culture, genetics, breeding and other matters. 'J.I.' composts are now widely used and have perhaps done more than anything else to make the name of the Institution familiar to gardeners. The annual report for 1947, recently issued, gives the results of many continued researches. M. B. Crane has obtained a certain amount of resistance to pear scab, *Venturia pirina*, from crosses between the pear varieties Giffard and Conference. Rogues in tomatoes are shown by D. Lewis to appear most frequently when the plants are grown at high temperatures (26° C.). The same author has analysed seven X-ray induced mutations of the incompatibility gene of *Œnothera*. They do not confer complete self-compatibility; but the work is being continued. K. Mather has investigated the three types of gene which affect heterostyly in *Primula sinensis*. The difference of morphology and physiology between pin-eyed and thrum-eyed flowers is determined by the major genotype, and finally adjusted by the polygenotype. Miss A. Vines has studied breeding system and genetic isolation in *Antirrhinum*, and A. J. Bateman has estimated the effect of various isolation systems on contamination in seed production.

Work on plant improvement by crossing has been carried out for uniform coloration of fruit in tomato (G. M. Haskell) and for combining the dwarf habit of *Phaseolus vulgaris* with the extended inflorescence of *P. multiflorus* (L. G. Wigan).

The Cytology Department, under Dr. C. D. Darlington, director of the Institution, has worked on the effect of cell gradients in controlling the development of nuclei in the pollen grain. The occurrence of dwarf pollen has engaged the attention of L. F. la Cour, who discusses the relative merits of segregation and differentiation as a cause. Further studies include the effect of X-rays on meiosis, and chromosome breakage by temperature shock. An interesting development in the Garden Department, under W. J. C. Lawrence, is the effect of artificial lighting on the yield of tomato plants. Daylight fluorescent tubes lit for 6 hr. a night for the first twenty nights after germination resulted in a much heavier yield of fruit, particularly in the first three weeks of picking.

The Institution is still carrying out its long-term programme of removal to Bayfordbury, Hertford; but it is expected to be some time before the transfer is complete.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Research Officer at the Division of Industrial Chemistry, Melbourne—The Chief Scientific Liaison Officer, Australian Scientific Research Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 1765 (September 4).

Head (male) of the Poultry Department at the Ulster Dairy School (for girls), Cookstown, Co. Tyrone—The Establishment Officer, Ministry of Agriculture, Stormont, Belfast (September 4).

Lecturer in Agriculture and Farm Bookkeeping, and a Lecturer in Agriculture, Farm Implements, Building Construction, etc., at the Cheshire School of Agriculture, Reaseheath—The Director of Education, County Education Offices, City Road, Chester (September 4).

Instructresses (2) in Dairying and Poultry-keeping—The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh 8 (September 4).

Chemist, and a Physicist—The Secretary, Hosiery Research Council, 4 First Avenue, Sherwood Rise, Nottingham (September 4).

Research Physico-chemist at the Research Institute of the Foot-and-Mouth Disease Research Committee—The Director, Research Institute, Pirbright, Surrey (September 4).

Demonstrator in Chemistry and Biochemistry with a special interest in Physical Chemistry—The Dean of the Medical College, St. Bartholomew's Hospital, West Smithfield, London, E.C.1 (September 4).

Lecturer in the Engineering and Mining Departments to take Electrical Technology and Mechanical Engineering with mining qualifications—The Registrar, University College, Cathays Park, Cardiff (September 4).

Lecturer in Entomology, an Agricultural Economist, and an Assistant Agricultural Economist—The Registrar, The University, Bristol 8 (September 4).

Lecturer or Assistant Lecturer in Physics—The Principal, College of Technology, Manchester (September 6).

Biologist (Technical Officer) as Head of the Biological Section of the Technical and Scientific Register—The Ministry of Labour and National Service, Appointments Department, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting G.351/48A (September 6).

Mechanical Engineer (Ref. C.528/48A), and a Standards and Co-ordination Engineer (Ref. C.529/48A), at the Atomic Energy Research Establishment, Harwell—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (September 6).

Agricultural Economist (male)—The Registrar, Wye College, Wye, Ashford, Kent (September 7).

J. G. Graves Medical Research Fellowship for full-time research in some branch of medical science approved by the Faculty of Medicine —The Registrar, The University, Sheffield 10 (September 11).

Assistant in the Engineering Department, London H.Q.—The Director, Personnel Department, British Council, 3 Hanover Street, London, W.1 (September 11).

Editorial Assistant (with degree in physical science with bias towards physics and mathematics) to the Royal Society—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.270/48A (September 11).

Lecturer in Anthropology with special reference to India—The Secretary, School of Oriental and African Studies, University of London, London, W.C.1 (September 11).

Senior Lecturer in Mathematics at the New England University College, Armidale, New South Wales—The Secretary, Universities Bureau of the British Empire, 32 Woburn Square, London, W.C.1 (September 15).

Assistant Bacteriologist (with an Honours Science Degree in Bacteriology), and an Assistant Biochemist (with an Honours Degree in Science and special experience in Biochemistry), to the Northern Regional Hospital Board—The Secretary and Administrative Medical Officer, Raigmore Hospital, Inverness (September 15).

Professor of Botany at Fouad I University, Cairo—The Director, Egyptian Education Bureau, 4 Chesterfield Gardens, London, W.1 (September 15).

Assistant Lecturers (2) in the Department of Civil Engineering—The Professor of Civil Engineering, Queen's University, Belfast (September 15).

Research Officer in the Building Research Section, Melbourne—The Chief Scientific Liaison Officer, Australian Scientific Research Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 1547 (September 18).

Assistant Lecturer or Lecturer in Agricultural Economics—The Registrar, The University, Leeds 2 (September 22).

Experimental Officers and Assistant Experimental Officers at the Department of Atomic Energy, Springfields, Lancs, to carry out experimental work arising from the metallurgical development involved in the production of atomic energy—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.391/48A (September 25).

Principal Research Officer in the Microbiological Division of the National Chemical Research Laboratory, Pretoria—The South African Scientific Liaison Officer, Africa House, Kingsway, London, W.C.2 (September 30).

Fisheries Assistant and Naturalist (temporary) for research at the Marine Biological Station, Port Erin—The Registrar, The University, Liverpool (September 30).

Chair of Mechanical Engineering—The Registrar, The University, Leeds 2 (September 30).

University Lecturer, preferably with special qualifications in Fluid Dynamics, Atomic Physics or Algebra—The Secretary of the Appointments Committee, Trinity College, Cambridge (September 30).

Readership in Metallurgy in the Department of Coal, Gas and Fuel Industries—The Registrar, The University, Leeds (September 30).

Kennedy Chair of Mechanical Engineering at University College—The Academic Registrar, University of London, Senate House, London, W.C.1 (October 7).

Director of Research at the Hosiery Research Council's Research Station at Thorneywood House, Nottingham—The Director, National Hosiery Manufacturers' Federation, 104 Regent Road, Leicester (October 15).

Chair of Geology at King's College—The Academic Registrar, University of London, Senate House, London, W.C.1 (October 25).

Professor of Civil Engineering, and a Professor of Electrical Engineering, at the Thomason College of Engineering (Roorkee University)—The High Commissioner for India, General Department, India House, Aldwych, London, W.C.2, quoting No. 412A (October 30).

Chair of Zoology at King's College—The Academic Registrar, University of London, Senate House, London, W.C.1 (November 1).

Fisheries Officers in Malaya—The Director of Recruitment (Colonial Service), Sanctuary Buildings, Great Smith Street, London, S.W.1.

Tsetse Fly Ranger by the Government of Nyasaland, for tsetse fly survey and reclamation duties—The Crown Agents for the Colonies, 4, Millbank, London, S.W.1, quoting M.N.21794/3F.

Scientists (*a*) with research and practical experience in Coal Mining, Coal Preparation and Carbonization and Briquetting (Ref. TT/70), and (*b*) to take charge of the Chemistry Laboratories and with all-round research experience with specialist knowledge in Coal Chemistry, Analytical work, Metallurgy or Coal Tar (Ref. TT/71)—The National Coal Board, Establishments (General) Branch, Hobart House, Grosvenor Place, London, S.W.1, quoting appropriate Ref. No.

Superintendent of the Scottish Laboratories, involving responsibility for all chemical, mechanical and micrographic testing, and for advisory service to Scottish members—The Secretary, British Cast Iron Research Association, Alvechurch, Birmingham.

Geologists for research on concentration of iron ore (*a*) with special knowledge of petrology or sedimentary rocks, (*b*) with experience of ore dressing problems—The Personnel Officer, British Iron and Steel Research Association, 11 Park Lane, London, W.1.

Research Assistant in Statistics (preferably with Degree in Mathematics)—The Lecturer in the Design and Analysis of Scientific Experiment, 91 Banbury Road, Oxford.

Senior Engineer in the Land Drainage Branch of the Public Works Department, Sierra Leone—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

Lecturer in Radio Engineering—The Clerk, Northern Polytechnic, Holloway, London, N.7.

Visiting Demonstrator in the Department of Bacteriology—The Secretary, King's College of Household and Social Science, Campden Hill Road, London, W.8.

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SECOND THOUGHTS ON UNIVERSITY EXPANSION

THE almost simultaneous publication of the Nuffield College Statement "The Problem Facing British Universities" and the symposium on "Entry and Careers" in *The Universities Quarterly* for August provides valuable material for further discussion on the expansion of the universities. The former Statement brings together much useful statistical information as well as collecting in its chapters on the demand for university graduates estimates of intake to the professions which are not otherwise conveniently accessible. Moreover, in the further chapter on the flow from the schools the Statement does something to meet a point made by Dr. Eric James, high master of the Manchester Grammar School, at the British Association conference on "The Place of Universities in the Community" last year, as well as to supply a factual background to Dr. J. F. Mountford and Mr. James Hemming's contribution to the symposium. Indeed, the Statement contains so much factual information that it is not easy to see the wood for the trees, and the conclusions seem to indicate that the members of the Nuffield Committee have not been entirely sure of themselves for that reason.

The Statement sets out in the first place to survey the chief demands made on universities, and after reviewing those made by the organised professions and other regular occupations which rely for recruitment on university graduates, including the demand for admission from overseas students, which is expected to be strong for some time, it considers the extra-mural work of the universities and the position of the higher technical and other specialized institutions. While the Statement does not commit itself to any quantitative estimate of the extent of university expansion, the Committee regards a permanent expansion as probable and appears to be satisfied that there is little risk of the large number of graduates failing to find employment. On the other hand, it formed the opinion that in the aggregate present demands are probably exaggerated, and that if the demands are pressed separately and dealt with piecemeal without consideration of their interrelation and aggregate effect, there may be real danger that legitimate but sectional needs will be met to the neglect of other needs of greater importance to the maintenance and development of the universities.

The Statement is thus first and foremost a challenge to fresh thought about the purpose and functions of a university, and as a result of that thinking to determine principles by which sound decisions can be made in balancing new claims against existing duties or one new claim against another. The Nuffield Committee does not, it is true, go very far in its analysis. It insists that in the first place there must always be an element of general education or culture in the teaching a university gives, and that, in the second place, this teaching must be given by scholars and men of science who are themselves working at the frontiers of knowledge. A university must maintain a reasonable range of studies, and not allow its desire to meet any one claim to turn it into a specialized institution restricted to serving the needs of a single profession or field of research, nor must any aggregate demands for teaching be allowed to deflect its staff from pursuing their own studies and research. The Committee observes here that it is at least a possibility that in the endeavour to give everyone whatever he wants, the universities may end by giving nobody what he requires.

The two chief suggestions made in the Statement to relieve the universities in meeting the immediate and short-term problems of expansion will be discussed in due course. The Committee recognizes that there is no satisfactory solution to the problem of meeting under present conditions the sudden expansion in the demands made on the universities. Its suggestion as to the extension of the extra-mural work of the universities has a bearing, however, on the long-term problem of expansion with which the universities are simultaneously faced.

The Statement suggests that universities which are adequately staffed might extend the opportunities which they offer to part-time students already qualified by previous education by allowing such students who are prevented from full-time residence to spread their study over a longer period than the usual full-time period, and by the provision of short special courses of the refresher type for those who can only come for a short period. The emphasis thus placed on the extra-mural and regional responsibilities of the universities is welcome: no short-term policy even which severely restricted the discharge of such responsibilities could wisely be accepted. Nevertheless, the Statement does not make it clear how the continuance or extension of such functions will contribute to ease either the short-term or long-term expansion. Like the question of size, on which also the Statement briefly comments, these functions appear to be mentioned chiefly as essentials to be kept in mind in deciding the exact purpose and functions of the universities.

Where the Statement is most disappointing is not so much in not indicating the Committee's own conception of a university and the precise purposes and functions it should serve, as in the absence of any constructive suggestion as to how we are to formulate such a conception or definition or to deal with those questions of geographical distribution of universities and the distribution of university resources among different projects where some co-ordination and concerted effort are essential. It rejects the proposal for a royal commission on universities as imposing a further burden on university administrators and teachers who are already overtaxed, without offering much hope of any kind of an early solution of problems. But to the crucial question whether the universities and the present University Grants Committee are competent to effect such a survey of needs and reforms or whether an external agency is required it gives no answer; but merely states the arguments for the alternative courses.

These arguments are admirably put, but what is required at the moment is decision. The Nuffield College Statement makes curious reading on this point, with Lord Lindsay as one of the signatories. Lord Lindsay's plea in the House of Lords debate on the universities in May of last year for a comprehensive review of the situation as a whole by some body other than the University Grants Committee is perhaps the most convincing argument yet advanced, not for the departmental committee which he suggested, but for the comprehensive and comparative survey which a Royal Commission alone could be expected to make.

However right it may be to hesitate to designate men and women for such a task when our ablest administrators are already often seriously overworked, that exigency is no more valid a reason for not examining the whole problem at the highest level than it is for not carrying out that survey of the machinery of government at the Cabinet and ministerial level for which the Select Committee on Estimates called in a recent report. Failure to conduct either survey may, and almost certainly will, involve waste of man-power at all levels immensely out of proportion to that involved in conducting the survey. So far as the universities are concerned, the brake on expansion imposed by the building situation may well afford the necessary breathing space for such a survey if a prompt decision is made as to the instrument to be used to conduct the survey. Nor need, it might be added, a royal commission, as opposed to the University Grants Committee, or some sub-committee of that body, employ the time of more than a very few of those actively engaged in university administration or teaching. Not only is there a sufficient reservoir of able minds with some experience and understanding of university problems, but much of the information is already being accumulated by various independent means or bodies; these activities and results require bringing together in a composite picture upon which judgment and decision can be based.

Except in respect of science students, where the analysis of available figures is somewhat limited, the Nuffield College Statement provides a fairly detailed comparison of the expansion of the different universities and university colleges in 1945–47 as compared with the situation before the War. The most interesting feature of the symposium in *The Universities Quarterly* already noted is the reference to a number of inquiries already conducted by the Technical Personnel Committee set up by the Ministry of Labour and National Service under the chairmanship of Lord Hankey, some of which do not appear to have been published. The quotations from these reports are complementary to the information in the Nuffield Statement and help to fill in some of the gaps that exist in our knowledge of the present situation and the probable demand for particular classes of graduates.

It is well known that while in the autumn of 1947 the number of students in British universities had risen from the pre-war 50,000 to roughly 77,000, the number of science students had practically doubled and stood at 14,500. As regards arts students, if the student population remains at about 80,000, there are expected to be about 12,000 graduates in each year from 1951 as against 7,000 before the War. In spite, however, of this increase in the number of science students, no substantial increase in the output of graduates available for employment outside the universities is expected before 1950. Thereafter there should be a rapid increase to about 5,000 each year or double the pre-war output. The first substantial increase in graduates in technology will likewise not be effective industrially until 1950, owing to the demands of military service, but by 1951 the output should be 3,400 each year as compared with 1,500 pre-war.

These are figures of which not only the universities but Government Departments as well as the universities should take careful note, and they should certainly guide the Advisory Council on Scientific Policy in considering the distribution or re-distribution of scientific man-power. Moreover, when the development plans of both large and small firms are already impeded by their inability to secure the recruits they require for research and production, with all that involves for industrial recovery and export, the situation disclosed by Mr. L. E. Ball in regard to particular categories is disturbing.

Mr. Ball, the secretary of the University of London Appointments Board, states in this article that there are at present sufficient chemical appointments vacant to absorb all new graduates in chemistry up to 1949 and that demand appears to be increasing steadily. Again, the Technical Personnel Committee, according to Mr. Ball, estimates the demand for chemical engineers for the next five years to be 240 a year as compared with a present annual output of less than 100. The reduction in new construction has, however, reduced the demand for engineers, and in engineering generally it seems that supply is in excess of demand.

This report from the Technical Personnel Committee would seem to be one of three reports which, according to Mr. Ball, have already been issued. One relating to mycologists and microbiologists, stated to have been issued in July 1947, indicated that the present output of microbiologists and mycologists is adequate and that a large expansion is not justified. A similar statement has been made of architects, and generally such inquiries as have been made by the Ministry of Labour and bodies like Political and Economic Planning indicate that most of the professional organisations do not expect any large increase in numbers once their war-time gap has been filled. Mr. Ball, however, expresses the hope that other reports dealing with chemists, biologists and physicists will come from the Technical Personnel Committee without delay, and the figures for physics honours students quoted by Sir Lawrence Bragg were presumably collected for this Committee.

Sir Lawrence Bragg points out that the honours physics schools of our universities are now producing about 600 graduates annually in place of a little more than 200 before the War, and returns from the universities indicate that this number is likely to be maintained for the next few years. Of these graduates in 1947 some 31 per cent entered careers in university or government research as against 29 per cent in pre-war years, 19 per cent entered industry in place of 30 per cent, and only 12 per cent took up a school teaching career as against 29 per cent before the War.

These figures are no less disturbing than those for chemistry graduates, and although the symposium in *The Universities Review* does not give any clear idea of the magnitude of the university expansion at which we should aim, it reinforces the argument for a comprehensive review of the whole situation and points also to the importance of associating industry with this review. Even from a short-term point of view the distribution of scientific man-power needs to be watched closely or there may be as serious repercussions on the flow of students to the universities for science courses as through the inability of industry to recruit the scientific workers it needs now so imperatively for research and production. Moreover, it seems clear also that only with the help of industry can serious unemployment among those who have graduated in arts be avoided during the next four years. Only in industry can openings be found for a considerable surplus over those who can find places in teaching and the professions, and there is real call for business men and industrialists to re-examine their recruiting policy and reconsider their needs for competent managers at the lower salary levels as well as at the directorate levels

At the entry side, both Sir Lawrence Bragg and Mr. J. Hemming direct attention to the question of quality. There seems to be little doubt that Great Britain's reserves of innate intelligence are sufficient to provide annually another 50,000 students of as high mental ability as those attending before the War. There is some doubt as to whether all those students would be forthcoming with the other specific aptitudes, including cultural standards, to make the most of a university life. Mr. Hemming is hopeful but Sir Lawrence is dubious. He has formed the impression that while we have not been missing many first-rate people, we are admitting to honours courses too many who would have profited more by training in much less ambitious courses.

The question of selection of students will be brought to the fore when the Working Party in State Scholarships and Major Awards reports to the Minister of Education shortly. The question of the cost of university education on which Mr. P. F. Vowles just touches in the concluding article in this symposium is bound to become increasingly prominent in discussions on university expansion. However fully we may subscribe to the belief that university education is an investment, it must be recognized that both the universities and the State have a duty to see that the considerable sums involved are wisely spent. It has been estimated that it costs £3,000 to provide a student at Cambridge with a three-year course. Even if his parents are prepared to pay £300 towards it, £2,700 has still to be found from public or university funds. Expenditure at the provincial universities is much less, but neither there nor at Cambridge can the nation as a whole afford to spend such sums on individuals who possess neither the brains nor the personality to profit from them.

Neither the Nuffield College Statement nor the symposium in *The Universities Review* does much more than indicate the range of problems to be solved and the imperative need for dealing with them as a whole and not piecemeal. Both challenge creative thinking about the purposes and functions of a university. Both indicate the urgent need for decision as to the body to whom that overall review is to be entrusted and for swift action as soon as the facts can be fully assembled and considered judgment made. It seems equally clear that if the nation's reserves of intelligence are to be trained and distributed to the best advantage, in that review must be joined the best minds that not only the universities but also industry and the nation as a whole can supply.

EVOLUTION IN MANKIND

A New Theory of Human Evolution

By Sir Arthur Keith. Pp. x + 451. (London: Watts and Co., Ltd., 1948.) 21*s*. net.

THIS book is the fruit of a long life of scientific work and meditation by a distinguished thinker with strong intuitions, trying to look towards a synthesis as yet seen 'through a glass darkly', and trying to make that vision clearer without limiting possibilities of its future adjustment. There is no attempt to force the facts to fit preconceived dogma, no riding of a pet theory to exhaustion.

The basic idea is derived mainly from Darwin, Romanes and Gulick. It is that isolated small, inbred groups are likely to diverge. This view is strengthened by the work of the geneticists, who show that in such a group dominant genes are likely to spread generally among the members, especially if they carry some character of value in the environment concerned. Defective genes may bring rapid extermination, especially if emphasized by close inbreeding.

Keith emphasizes the smallness of the hunter-collector groups in several environments; and he might have made more of the probability that in that stage of social-economic development, Britain is not likely to have had more than a few hundred people in scattered small groups. He directs attention very justifiably to the territorial bases of the little early group which he, in common with all other scientific observers, regards as a basal feature of our heritage from prehuman ancestors. Society is not primarily a human construction, and whatever we may say about social elaborations, they are, as it were, shoots on a prehuman trunk. The territorial basis may be a hunting-range, including perhaps a water supply and so on; the group will typically resent intrusions of strangers and will combine to defend the territory. Here we have Spencer's code of amity within the group and code of hostility outside it, both features of the ethical make-up of mankind, the disharmony between which is our permanent problem. But Keith is concerned with the fact that the code of hostility promotes inbreeding and differentiation, in language and custom as well as in physique; and, at an early stage, the more diversity the less interbreeding. Differences of language and custom are thus factors of isolation which he thinks may be more powerful than mountain or desert belts.

The small group has tended to remain poor, and larger associations of groups have come into existence, with decreasing uniformity in physique, but sometimes enforced uniformity in language and custom. Inbreeding, dangerous as well as sometimes useful, is less and becomes less still when one group conquers another, and the conquerors, mainly young men, take to themselves the girls of the conquered people. The larger and more complex group has more to defend, and around this gathers the emotion of patriotism; this in turn promotes breeding within the group, so the self-conscious, patriotic group may differentiate itself, even physically, from others in the course of time. A tribesman, says Keith, is apt to transfer his own emotions and impulses to his tribe or group, and we know the power of that group impulse, especially in connexion with the code of hostility. Russel Wallace was the first to emphasize group-solidarity and the accompanying selection between groups as a factor of evolutionary differentiation.

Keith emphasizes fœtalization as a factor of evolutionary differentiation. The forehead and many other features in women are usually nearer the fœtal stage than those of men. Mongol features, so called, including a low and retracted nasal bridge, an epicanthic fold over the upper eyelid and protuberant eyeballs, are fœtal and transitory in a proportion of Europeans, but durable in parts of Eastern Asia and among the majority of Hottentots. These resemblances are not necessarily indications of close genetic relationship.

It has seemed best to try here to give a fairly general picture of Keith's views. The book reviews many stages of human social, as well as physical, differentiation and gives the author's considered opinions. He adheres, for example, to the view that the Piltdown skull and jaw belonged to one and the same individual, arguing against the opinion that they are of different species but not mentioning the bare possibility that the skull might be that of a female and the jaw that of a male.

Keith's idea of inbreeding groups as in process of differentiation leads him to think of them as possibly races in the making; but most groups of the present time are heterogeneous and likely to remain so, and it might be better to use some term other than that of race in this connexion.

The book is one for careful meditation, and is an interesting monument of a respected and beloved personality. H. J. FLEURE

TOWARDS A MATHEMATICAL SOCIOLOGY

Mathematical Theory of Human Relations

An Approach to a Mathematical Biology of Social Phenomena. By N. Rashevsky. (Mathematical Biophysics Monograph Series, No. 2.) Pp. xiv + 202. (Bloomington, Indiana: Principia Press, 1947.) 4 dollars.

IT is only in quite recent times that mathematical methods have been applied in the social sciences or, indeed, in those fields, such as psychology, where the natural and the social sciences overlap. The use of mathematical-statistical methods in the handling of data, as in biometrics or econometrics, has developed rapidly in recent years. The employment of mathematics as a tool of analysis in the development of theory has been neither as general nor as successful. Mathematical economics, like mathematical biology, is taking its place in the general body of theory, and the time is ripe for extensions into other social sciences. What the author of this book attempts is a sketch of the possibilities of a mathematical sociology. He is where the mathematical economist or biologist was some decades ago, experimenting with alternative formulations and various types of simplification. He has a wider and more difficult field than the economist or biologist but; since his science overlaps with theirs, he can draw upon their experience.

I can give no more than a brief indication of the scope of the author's essay. He attempts a theory of the way in which classes or groups are formed, of their size and number. He considers the interaction of one group with another within the social structure and, in particular, the various kinds of conflict from economic exploitation to war. He develops the characteristics of individualistic as against collectivistic societies. He has a good deal to say on the dynamics of the growth and decay of groups; for example, the controlling power of a group, derived by inheritance from past generations, may become unstable. He finds that a rather general formulation involves complicated integral equations; but, by simplification of his models, he is able to proceed with differential equations and with ordinary problems of maximum and minimum.

The author would, I think, agree with me in stressing two aspects of his work. One is that he is experimenting with various mathematical formulations, most of which may not lead to anything fruitful. Even so, the work is not wasted. It is always useful to translate into mathematical terminology the different theoretical situations studied; in this case the growth and interactions of groups in the social structure. This serves, at least, to clarify the nature of the assumptions on which the theory rests and to distinguish sharply between the various possibilities.

The second aspect is that, eventually, any mathematical theory must be developed to the point where it can be put to the test with actual data and lead to prediction. The author's theoretical constructions are, he admits, crude and oversimplified descriptions of a modern society. But, if only for illustrative purposes, he ventures to introduce actual data from time to time to match against his theoretical results.

Against these merits must be set certain weaknesses, many perhaps inevitable in a pioneering study. I think the author has been ill-advised to publish his work in book form so early in its development. With more time, he might have shown greater discrimination in his selection of formulations for development; he might have cut out some weaker threads and tied up some of the stronger but loose ones. He is at his weakest where he analyses the economic aspects of social groupings. He admits that much of what he does must appear crude to an economist, but feels that his simple approach is necessary to "bring out the social aspect of the interrelation of economic classes" (p. 40). Perhaps so, but I feel that he can only say this after a close examination of the work of mathematical economists. His references make it clear that he has not read widely in this field. He is much influenced by two or three writers, particularly G. C. Evans (referred to throughout as G. E. Evans), whose work dates back to the 1920's and early 1930's. He displays no knowledge of later work, particularly in economic dynamics, which would be of more help to him. He would find, for example, that mathematical economists first followed physicists in using differential equations but afterwards turned to difference equations as more appropriate to their subject, and (incidentally) discovered them to be just as easy to handle. His assertion that "no successful application of mathematics to social phenomena has been made" (p. iv) is not true of at least one branch of the social sciences.

R. G. D. Allen

THE UNIFORM CALCULUS

A Text-Book of Mathematical Analysis

The Uniform Calculus and its Applications. By R. L. Goodstein. Pp. xii + 476. (Oxford: Clarendon Press; London: Oxford University Press, 1948.) 30*s*. net.

THE problem of presenting the infinitesimal calculus to schoolboys and university students who seek to acquire a knowledge of it for applications in other fields is notoriously difficult. Methods based upon geometrical intuition lack rigour and to the thinking student produce an impression of mystery. Methods based on a rigorous theory of real numbers are suited only to the student who is to become a mathematical specialist.

Dr. Goodstein proposes to avoid the difficulty by a simplification of the calculus itself, by restricting his treatment to functions which possess uniform differentiability. The foundation-stone is the notion of a convergent sequence of terminating decimals, which is then extended to convergent sequences the terms of which are endless decimals. The notation $0(r)$ is used to signify any number which is zero to r places of decimals, that is to say, a number the positive value of which is less than $1/10^r$. A function $f(x)$ is said to be uniformly differentiable in the interval (a,b) if we can find functions $f'(x)$ and $n(r)$ such that

$$\frac{f(X) - f(x)}{X - x} = f'(x) + 0(r)$$

for any numbers X, x in (a,b) which satisfy $X - x = 0(n(r))$.

The (uniform) derivative $f'(x)$ thus defined exists for all the usual elementary functions which the student is likely to encounter, in particular for the circular and exponential functions.

It is then proved that a uniform derivative is a continuous function, and that a function uniformly differentiable in (a,b) is continuous in (a,b).

On this basis, and with suitable definitions of integrals, the uniform calculus is built up in such a manner that the ideas can be appreciated by a student who has only a modest knowledge of arithmetic and algebra.

The first eleven chapters contain all the calculus that is needed for the ordinary and advanced papers of the higher school certificate examinations. The whole book covers the calculus syllabus for the general honours degree of London and provincial universities and the London special degree.

The demonstrations are lucid and often original, and the student should profit by the examples of technique so well illustrated in every chapter. The standard functions e^x, $\sin x$, $\cos x$ are defined by their expansions in power series and are introduced in a natural and satisfying manner.

The author has purposely given no diagrams in order to prevent the possibility that geometrical intuition may disturb algebraic reasoning. One might, however, expect a certain amount of sales resistance from a certificate student to the statement that the area bounded by a simple closed curve is

$$\left| \tfrac{1}{2} \int_{t_0}^{t_1} (xy' - x'y)dt \right|,$$

with the added note that a rigorous proof belongs to the theory of double integrals and is postponed to Chapter 17.

The book is certainly a contribution of outstanding merit to the very few serious efforts which have been made to present limiting processes to the student at a level which he can readily understand, and which at the same time will leave him nothing to unlearn at a more advanced stage. The book contains more than four hundred worked examples.

L. M. MILNE-THOMSON

SCIENCE IN RELATION TO HISTORY

Science and its Background

By Lieut.-Colonel H. D. Anthony. Pp. ix + 304. (London: Macmillan and Co., Ltd., 1948.) 10*s.* 6*d.* net.

THERE are many ways in which authors have dealt with the history of science. This important subject can appear as a plain chronology of scientific development without any account of its relations to contemporary thought, it can take the form of a series of 'great lives' given with anecdotal treatment, or it may trace the parallel evolution of philosophic thought at each stage. The work here reviewed is eclectic in its methods: it envisages the story of science through history, and, moreover, a history which takes account, as all histories should, of human development and the evolution of social institutions. The author, a former grammar school headmaster, is the chief inspector of education in the British Army, and if the contents of the book are an indication of what is done in adult education in the Services and elsewhere it is a happy sign of the times. In its three hundred pages the book deals with many subjects. The author has succeeded in being succinct without being superficial by a careful selection of the most important topics for his purpose.

The form of the book is original in its layout and in the grouping of the material. The great movements in the advance of scientific knowledge are considered under the following headings: the beginnings of science in the "Rivers Period", the Mediterranean Period (Classical and Medieval), the Atlantic Period (Renaissance to Modern), the World Period (International Conflict and World Co-operation).

The main need in the teaching of science at present is not an improvement in practical techniques, nor of further specialist subdivisions of the science subjects. The dichotomy between what so often passes in school and university for science and culture is a matter which exercises the minds of many mid-twentieth century thinkers. There is an urgent need for seeking a new synthesis, and as a guide the book here reviewed would make a good introduction. The author is always fair, and evinces no emotional, political or religious biases which make a mockery of the scientific spirit and mar so many works on the relations of science with other forms of human activity.

The book should be read by every sixth-form pupil, whether of arts or science. For the lay-reader requiring a short, readable and accurate account of the growth of science in its human context, it is difficult to see how it could be improved.

The production of the book in general and its pictures and time-charts in particular reach a high standard.

W. L. SUMNER

INSECTICIDES AND FUNGICIDES

A Catalogue of Insecticides and Fungicides

Vol. 1: Chemical Insecticides. Compiled by Prof. Donald E. H. Frear. (Annales Cryptogamici et Phytopathologici, Vol. 7.) Pp. xii + 204. (Waltham, Mass.: Chronica Botanica Co.; London: Wm. Dawson and Sons, Ltd., 1947.) 6.50 dollars.

THERE is a large and expanding literature concerned with the control of insect pests by the use of chemicals, derived either from plants or synthesized in the laboratory. The number of compounds tested for this purpose is already very great, and the relevant information is scattered through many original papers. Many workers in this field undoubtedly have references to much of it filed away, but it is only the relatively widely used compounds that are essentially borne in mind when particular problems arise. Not only so, but in all branches of human knowledge the recording and indexing of information demands great expertness if it is to be readily available. Prof. D. E. H. Frear has obviously applied considerable expertness and a vast amount of labour in accumulating and arranging this catalogue of compounds, tested or employed at one time or another for the control of insect pests, with the appropriate references to original or review papers and to the patent literature.

The compounds are not arranged alphabetically, and before the catalogue can be used with advantage it is essential that the coding system employed be studied with some care and mastered. This requires a certain amount of knowledge of chemical terminology; but briefly, a code number is assigned to each constituent group of a compound, which is specified by arranging these in consecutive order, beginning at the lowest. Thus D.D.T. is expressed by a number, 855–952–1011, which was turned up quite rapidly, only to find no references to the literature were given; the author, however, explicitly rules out from his survey the better-known insecticides for which review papers and monographs are in abundant supply. It is for the less-known compounds that this record will be of use to the research worker. It is, perhaps, natural that the greater proportion of the references are to papers in American journals and to the bulletins of American research stations, but if this experiment succeeds, doubtless the range will be made wider in future editions.

It is to be regretted that the alphabetical index of the compounds has been relegated to the end of Volume 2, since if insecticides and fungicides deserve separate volumes—which they do—they should each have had their own index. It would not only have made this volume of greater value to those investigators whose knowledge of chemistry might be deficient, but also it might have made the array of facts in the book more rapidly accessible to others.

CENTENARY OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

By Dr. F. R. MOULTON
Administrative Secretary

FROM September 13 until September 17 the American Association for the Advancement of Science will hold in Washington, D.C., the centennial celebration of its founding. It was born in Philadelphia, Pennsylvania, on September 20, 1848.

The A.A.A.S. (to use the customary abbreviation of the present time) owes much, particularly in its earlier years, to the pattern set by the British Association for the Advancement of Science, which was organised in 1831. There were still earlier scientific societies in Great Britain and also in the United States, but they were somewhat different in character. The American Philosophical Society of Philadelphia was formally organised by Benjamin Franklin in 1743, and the American Academy of Arts and Sciences was granted a charter in Boston in 1780. The first attempt at establishing a truly national scientific society in America was the launching in 1816, under political sponsorship, of the Columbian Institute for the Promotion of Arts and Sciences. It flashed like a meteor and soon disappeared. Some years later, in 1840, the National Institution for the Promotion of Science was established by an Act of Congress. In 1844 it held a meeting at which John Tyler, then president of the United States, delivered the opening address. Government officials of high rank served as chairmen of the scientific sessions, at which forty-three papers were presented. The Institution never held another meeting.

A few years earlier, in 1837, Dr. John Collins Warren, of Boston, had attended a meeting of the British Association. It impressed him so favourably that upon his return to America he actively began to promote the establishment of a similar society in the United States. The failures of grandiose plans on one hand, and the limitations and weaknesses of small special societies on the other, directed the attention of American men of science to the founding of a scientific society national in scope and embracing all the sciences. This culminated on September 20, 1848, in establishing the American Association for the Advancement of Science, with an initial membership of 461. At the first meeting about thirty papers and oral communications were presented before the "Section of Natural History, etc.", and about as many before the "Section of Physics, etc.", the two subdivisions of the Association at that time.

The first period in the existence of the A.A.A.S. extended from its founding in 1848 until the outbreak of the Civil War between the northern States and the southern States, in 1861. In this interval of fourteen years thirteen meetings were held in different cities in the eastern part of the United States, and one was held in Montreal, Canada. The two original Sections of the Association were gradually divided into more specialized fields. The membership varied from the initial 461 in 1848 to a maximum of 1,004 in 1854.

In 1861 the Civil War broke out, and for five years the A.A.A.S. held no meetings, it elected no presidents or other officers, it issued no publications, and memories of its earlier meetings were dimmed. However, a meeting was held in 1866; but it was not such a meeting as earlier ones had been. The attendance was small, the papers presented were few, and the membership of the Association had declined below that with which it started. The conditions prevailed, generally, for about a decade, or until 1878.

In 1878 the membership of the Association was 962; in 1888 it had increased to 1,964, and it remained at about that level until 1900. Members of the A.A.A.S. were at its beginning and always have been on an annual basis, their dues being paid but once a year. Initially the dues were 1 dollar a year, but increased to 2 dollars in 1851, to 3 dollars in 1874, and finally to 5 dollars in 1920. Beginning with 1900 each member received with his membership a subscription for the weekly journal *Science*, and since 1915 a subscription for either *Science* or *The Scientific Monthly*. At the beginning of this calendar year (1948) the annual membership dues, including a subscription for either of the two journals, became 6.50 dollars a year.

An evolution in the structure and functions of the A.A.A.S. began in the closing decades of the nineteenth century and has continued until the present time. With the progressive specialization in science, the number of sections of the A.A.A.S. steadily increased. As their memberships grew they gave rise to the organisation of special societies—in mathematics, physics, geology, botany, etc. Many of these societies grew rapidly, and their memberships increased to such an extent that it became desirable for them to meet separately in order to obtain adequate accommodations in any American city. In a sense these developments appear to be the reverse of the integrations of science that were achieved when the Association was founded. But integrations of the sciences consist of something more than simultaneous meetings. The interrelations among them have been preserved by maintaining fifteen sections of the A.A.A.S., covering broadly all the principal sciences, the joint programmes of which with one another at the Association's meetings provide the cross-fertilization of ideas so important for vigorous scientific progress.

The outcome of this evolution in the organisation of American science has been a federation of co-operating scientific societies—the A.A.A.S. and its 207 affiliated and associated societies, the combined membership of which now totals several hundred thousands. Each of the 120 affiliated societies has either one or two representatives on the Council of the Association, who together constitute a large majority of the Council; the 87 associated societies are not represented on the Council. The affiliated and associated societies pay no membership fees or dues to the Association or fees for participating in its meetings. The harmony and co-operation of these many scientific societies in advancing science and human welfare present an inspiring example in a contentious and disordered world. It is the purpose of the A.A.A.S. to co-operate much more widely in the future with similar scientific societies in other countries and continents.

Now turning from a brief sketch of the evolution of the plans and ideals of the Association, the statistical story will be resumed, for it is the combination of both the principles and the practices of an organisation that measures its success. Membership statistics of the Association during its first half-century have been sketched. In 1900 the total membership of the Association was 1,925. In that year the weekly journal *Science*, owned and edited by Dr. J. McKeen Cattell, became the official publication of the Association. By 1908 the membership had become approximately 8,000, and it remained about the same until the close of the First World War, after which it increased rapidly for a decade. It exceeded 15,000 in 1928 and 18,000 in 1938. Now it exceeds 40,000.

There has been a geographical expansion of science, as well as a great increase in the number of men of science, in the United States. In 1916 the Pacific Division of the Association was organised by members of the A.A.A.S. who lived in the great and now populous States on the Pacific coast, about three thousand miles from the large cities in the East and two thousand miles from those in the Middle West, the regions in which meetings were generally held. In 1920 the South-western Division was similarly organised for the convenience of members who live in the south-western States. These Divisions of the Association are wholly autonomous in the election of their officers, the organisation of their annual meetings, and their relations with other scientific societies in their respective areas. The Pacific Division now has more than 4,600 A.A.A.S. members and the South-western Division nearly 800.

Perhaps the most effective way of describing the current policies and activities of the A.A.A.S. is to present a few statistics of the meeting that it held in Chicago during December 26–31, 1947. Although registration at the meetings of the Association has not been generally required, there were 4,940 registrants at the Chicago meeting, each of whom received a general programme. There were, in addition, several thousand persons for whom programmes were not available. As an illustration of the number of men of science at the meeting from a limited field, the official tabulated attendance at the annual "Biologists' Smoker" was 5,575—substantially greater than the total registration from all fields.

There were registrants at the Chicago meeting from every one of the forty-eight States, and also from Alaska and Hawaii. There were seventy-three registrants from Canada, twenty-eight from India and fourteen from China. There were 105 registrants from California, about 2,000 miles westward from Chicago, and 102 from Massachusetts, about 1,000 miles in the opposite direction.

A total of 2,019 papers were on the programme, of which 1,809 were presented orally, 46 consisted of demonstration and informal discussions, and 164 were read by title only. They were distributed among 340 sessions, the maximum number held simultaneously being 41.

It should not be assumed from the large number of men of science attending the "Biologists' Smoker" that the meeting was dominated by biologists or by scientific workers from any other particular field. Nor should it be assumed that the number of men of science was small from the fields in which there are large special scientific societies (the American Chemical Society, for example, or the American Medical Association), which hold their own large meetings quite independently of other scientific societies. At the Chicago meeting of the Association 4,288 registrants recorded their fields of specialization, in part, as follows: fields in which the special societies meet with the A.A.A.S.—zoology (822), biology (498), botany (903); fields in which the special societies hold independent meetings—chemistry (678), physics (296), medical sciences (354), agriculture (176), education (100).

As a consequence of the large attendance at the Association's meetings of specialists from every field of science, it is possible to organise and hold joint symposium programmes on subjects that are not limited by the usual boundaries of the various sciences.

An important feature of the Chicago meeting of the A.A.A.S. last December was the address of Dr. James B. Conant, retiring president of the Association and the president of Harvard University, entitled "The Role of Science in Our Unique Society". There were also ten scholarly addresses by retiring vice-presidents of the Association which in general were surveys or summaries of the fields of science of the Association's sections of which they were the respective chairmen.

In addition to these official programmes, there were seven sessions for special lectures or discussions of various aspects of the role of science in human affairs. Finally, there were fifty symposia on broad sectors of science of high current interest and importance.

As the present officers of the Association look back over the century of progress in organised American science made by their predecessors they have only feelings of gratitude and admiration for the high ideals which moved them and the success which crowned their efforts. As the present officers look with anxiety toward the future they can only say (to paraphrase the closing words of Milton's "Paradise Lost") that all the world is before them and Providence their guide. To paraphrase the opening invocation to "Paradise Lost", they can only say to the Heavenly Muse, what in us is dark, illumine, what is low, raise and support, that we may rise to the height of the great opportunities before us and justify our confidence in the powers of science to improve the lot of man.

ANTIBIOTIC ACTIVITY OF GROWTH-FACTOR ANALOGUES*

THE most striking reactions associated with the growth of micro-organisms are synthetic ones, particularly those concerned with protein synthesis. The synthesis of each compound is a stepwise process, each step being catalysed by an enzyme; if the necessary enzyme is in some way inhibited or has been lost during evolution of the organism, then growth will be slowed down or stopped unless the product of the reaction in which that enzyme was involved is now provided in the external environment. When the synthesis of a compound essential for growth is impossible through natural loss of an enzyme system, then that compound becomes for the organism a 'growth-factor'. By this term it is not meant to imply that the compound in question is not essential for those organisms which do not require it to be present in the external environment; all growth-factors investigated have been shown to be synthesized by a wide variety of organisms which do not require them pre-formed and, where these are known, to have the same functions as in the more exacting organisms. Thus it seems justifiable to consider all growth-factors as 'essential metabolites' and to regard the differences in requirements for them as differences in synthetic ability of the organisms investigated. On this basis, interference with the functioning or further utilization of the essential metabolite would produce the same metabolic lesion in those organisms which are able to synthesize it as already exists naturally in those which are not.

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* Based on a discussion held at the Royal Society on June 17. There took part in the discussion, which was opened by Sir Paul Fildes, F.R.S., Dr. D. D. Woods, Dr. H. McIlwain, Dr. T. S. Work, Dr. H. N. Rydon and Dr. F. L. Rose; Dr. J. Walker, Dr. A. Albert and Prof. M. Stacey also contributed.

The concept of 'substrate competition' was already well established at the time that the mode of action of the sulphonamide drugs was demonstrated. For example, malonate was known to be sufficiently like succinate to be able to form a complex with succinic dehydrogenase, but to be unlike it enough not to go through the stages of dehydrogenation and dissociation. If enough malonate was present, most of the enzyme became involved in formation of the more stable complex; the enzyme was, in fact, inhibited by malonate which was competing with succinate for the attention of the enzyme. This inhibition could be reversed by increasing the concentration of succinate, renewed by adding more malonate, and so on. In just such a way the sulphonamides are held to compete with *p*-aminobenzoic acid, and to prevent its further utilization. Although a certain amount is known about the functions of *p*-aminobenzoic acid, little is known about the receptors with which the competition is concerned Possibly the sulphonamides form complexes with an enzyme or series of enzymes, analogous to the malonate – succinic dehydrogenase complex. Possibly they form complexes with a compound normally associated with *p*-aminobenzoic acid and thus interfere with its function; it has been suggested that reductone may be such a compound, and reductone-*p*-aminobenzoic acid and reductone-sulphonamide complexes have been demonstrated.

Whatever the exact point of attack of the sulphonamides, it was clear that they acted by competing with *p*-aminobenzoic acid, shown to be a growth-factor for a wide variety of organisms, and considered to be an essential metabolite at least for those which are sulphonamide-sensitive. Realization of this, together with the marked chemotherapeutic success of the sulphonamides, stimulated the development of the Fildes – Woods 'rational approach' to chemotherapy. Briefly, it was suggested that analogues of known bacterial growth-factors (or essential metabolites) might be found to bear the same relationship to the parent growth-factor as the sulphonamides bear to *p*-aminobenzoic acid and thus prevent their utilization (or synthesis). Such analogues should prevent or slow bacterial growth and might thus prove to be of use as chemotherapeutic agents.

Several hundred analogues of compounds known to be of importance to the cell have been synthesized and many of them possess the predicted bacteriostatic property *in vitro*. Of the active compounds many are inactive *in vivo*, and others are too toxic to the host to be considered as chemotherapeutic agents. Only certain analogues of pantothenic acid (for example, phenylpantothenone) retain their property of inhibiting growth of the micro-organism *in vivo* and at the same time fulfil the other requirements of a chemotherapeutic drug; had it not been for the development of other antimalarial drugs, phenylpantothenone might to-day be regarded as a practical achievement for the rational approach. Superficially, however, this approach has yielded nothing of chemotherapeutic value; but certain points must be considered before passing judgment. The first concerns the choice of factor. Such is the fundamental similarity of metabolic patterns in all cells that an agent which interferes with a given process in one cell is likely to interfere in a similar way with the metabolism of another cell, independent of species. The repetition of metabolic patterns is seen most clearly in the case of the B group of vitamins. Members of this group have an extremely wide distribution as essential metabolites, and analogues of them have been synthesized and tested in the greatest number. It is not difficult, therefore, to understand the failure of these analogues in chemotherapy, for they interfere with the same fundamental processes in both parasite and host; indeed, several analogues, such as those of aneurin, nicotinic acid and folic acid, have produced in mammals syndromes indistinguishable from those produced by simple dietary deficiencies of the factors concerned.

The relationship between an inhibitory compound and the growth-factor on which it is modelled tends rather to be taken for granted. An analysis of any existing relationship and of the metabolic effects produced by the antagonism is desirable not only for a proper understanding of the mode of action of the analogue (and thereby of the corresponding growth-factor) but also so that the development of more efficient inhibitors should proceed logically. Evidence for the existence of a relationship is of three main types. First, the actual existence of a mutual antagonism has to be demonstrated between growth-factor and analogue. This aspect has been very widely studied and has been the subject of several reviews. Second, even though such an antagonism is established, it should not be assumed that growth inhibition is solely due to it. Specificity of action should be examined in as wide a variety of organisms as possible, and reversal of the inhibition should be limited to the growth-factor in question and to any compounds which may replace it in the growth of organisms requiring it. Finally, the effects produced by the analogue should be just those which are seen as the result of a nutritional deficiency of the growth-factor.

It is desirable also that the exact point of attack of the inhibitor should be investigated. This presents a complex problem, for the various possible processes which can be interfered with are all closely interrelated, and it is not easy to separate primary and secondary effects. Of the three main points at which an analogue can cause a block, the first two, assimilation of the growth-factor and its elaboration into a functioning form, are particularly difficult to separate. No instance of an analogue preventing the assimilation of a growth-factor is known, though little work has been done on this aspect. Most work has been concentrated on the metabolism of the factor once it has entered the cell, and this includes studies on the further elaboration of the growth-factor molecule. As instances, the conversion of *p*-aminobenzoic acid to folic acid and its inhibition by sulphonamides, and the conversion of glutamic acid to glutamine and its inhibition by the sulphoxide of methionine might be cited as examples. In the second example it is also known that the methionine sulphoxide does not interfere with the assimilation of glutamic acid from the external environment but only with its conversion after entry into the cell. The third point at which analogues may exert their effect is during the actual functioning of the growth-factor, that is, at the point of catalysis. Here again there is very little information available, although the hydrazide of glutamine has been shown to inhibit the breakdown of glutamine to glutamic acid and ammonia, and to be correlated with the inhibition of the growth of streptococci caused by the hydrazide.

To obtain by the rational approach analogues which possess the selective toxicity so necessary for successful chemotherapy, processes must be blocked which are quantitatively more important, or peculiar, to the parasite. It seems unlikely that the sulphonamides are the only analogues of an essential metabolite which fulfil this requirement; with increase in our knowledge of the metabolism of micro-organisms and of the parasite-host relationship, it is probable that more agents will become available. The sulphonamides owe their chemotherapeutic success to the inhibition of a reaction which seems to be absent from animals but essential to micro-organisms (and to members of a number of other species). In several bacteria the sole defect produced by the sulphonamides seems to be an inhibition of the incorporation of *p*-aminobenzoic acid into the folic acid molecule. Animals cannot carry out this synthesis and rely upon a supply of pre-formed folic acid being present in the diet; in other words, the biochemical lesion induced in sensitive organisms by the sulphonamides already exists in the host. Nevertheless, the host may be partially dependent on factors synthesized by its intestinal flora; the effect of sulphonamides on such syntheses may account in part for the toxicity sometimes seen in sulphonamide therapy. Moreover, it is known that much of the folic acid present in animal tissues and fluids is in the form of conjugates, a form not available to the parasite. The position, then, is that formation of folic acid by the host-dwelling parasite is blocked from below by the sulphonamides and from above by natural lack of the enzymes necessary for releasing folic acid from its conjugates; the host, on the other hand, relies on a supply of pre-formed folic acid and converts it largely to a form not available to the parasite.

A similar situation may explain the partial success of analogues of pantothenic acid, for this factor is known to exist in animals in the form of co-enzyme A, a more complex molecule. Although micro-organisms carry out a similar elaboration of pantothenic acid, they do not seem to be able—through inability to absorb it or through slight differences in structure—to make use of animal co-enzyme A to supply their own requirements.

The sulphonamides, and possibly also analogues of pantothenic acid, thus provide examples of compounds which interfere with reactions peculiar to the parasite and exploit qualitative differences in metabolism. Further inhibitors of this type, as already stated, will develop logically from the finding of further synthetic reactions of the parasite. A hopeful field, already opening out, is associated with peptide metabolism. Species specificity of structure is nowhere so marked as in the proteins, and it is in their synthesis that species-specific biochemical reactions are most likely to be found. For example, a certain amino-acid sequence in a simple peptide might be harmless or even favourable to one species, but toxic, through slight differences in sequence from normal peptides of that species, to another. It is interesting to note in this connexion that several of the naturally occurring antibiotics are peptides. One of them, lycomarasmin, is the tripeptide seryl-glycyl-aspartic acid. Its toxicity towards *Lactobacillus casei* and the tomato plant (it is the active agent of the tomato-wilt fungus *Fusarium lycopersici*) is annulled competitively by strepogenin, also a peptide and a growth-factor for a number of organisms. The observed biological relationship suggested a possible chemical relationship (using the rational approach 'in reverse'), and the synthesis of seryl-glycyl-glutamic acid yielded a compound with some strepogenin activity, both as growth-factor and as antagonist to lycomarasmin. On this and other grounds, it is not impossible that other natural antibiotics may turn out to be analogues of essential metabolites; there is already some evidence for this in the case of streptomycin.

For successful chemotherapy, though, it may not be necessary to restrict attention to reactions which are peculiar to the parasite. The temporary blocking of processes quantitatively more important to the parasite than to the host might prevent growth of the former for long enough to allow the natural defences of the host to overcome the invader without seriously damaging the host.

Another point to be considered is that, although the rational approach has yielded little in the way of chemotherapeutic agents, it has provided metabolic tools of the greatest value in investigating the actual function of the growth-factors. As they inhibit specifically the synthesis or utilization of the growth-factor, they provide a chance of tracing the primary effect of that factor. For example, γ-3,4-urylene-cyclohexylbutyric acid, an analogue of biotin, inhibits the growth of *Lactobacillus arabinosus*, and this inhibition is reversed competitively by biotin. The amount of biotin required to overcome the inhibition by a given concentration of the analogue is decreased ten-fold if oxaloacetic acid is present. This indicates that one function of biotin is in the synthesis of oxaloacetic acid.

Similarly, use of the sulphonamides has contributed greatly to knowledge of the function of *p*-aminobenzoic acid, which is involved in the synthesis of folic acid, purines, thymine, methionine, lysine, serine and possibly valine. Inhibition of the synthesis of folic acid by sulphonamides has been demonstrated in a direct way. Further use of the analogues in such researches may well reveal points suitable for chemotherapeutic interference.

When a suitable growth-factor or essential metabolite has been selected for modification, it has yet to be decided what changes are to be wrought in the original molecule to produce an efficient inhibitor. So far it has only been possible to predict in a very general way whether a given analogue is likely to prove inhibitory. Trial and error may be costly of time and fail completely to give an active compound, for it is not enough to go on simple pictorial analogy. It is not enough because an analogue may look like a metabolite and yet lack the chemical groupings necessary for combination with, for example, an enzyme; and because it leads to over-emphasis of the geometry and under-emphasis of the chemistry of the molecule. At the same time, pictorial analogy is too much, for it leads to possible overloading of the analogue with unnecessary groups which have nothing to do with the attachment of it or the metabolite to the enzyme. In order to model inhibitors more successfully on essential metabolites two things at least must be known: first, the structure of the metabolite to be imitated; and secondly, the precise way in which it associates with the bacterial enzyme to which it is related as substrate, co-enzyme or product.

Many attempts have been made to explain the action of the antimalarial drugs on the basis of their being metabolite analogues, and there is much evidence, both chemical and biological, that quinine, 'Mepacrine' and 'Pamaquin' and possibly also the more recent anilinopyrimidines act as inhibitors of reactions involving riboflavin, at any rate in bacteria. As pointed out above, the fact that a substance chemically related to a growth-factor can compete with that growth-factor does not of necessity imply that an associated growth inhibition can be correlated with the metabolite analogy. Thus the final biological proof that these antimalarials are active solely because tinthey erfere with the action of flavin derivatives has yet to be provided. The newer and highly successful 'Paludrine' was developed by logical chemical steps from 'Mepacrine'; yet in no system has it been shown as a riboflavin competitor. There is no biological evidence for the mode of action of 'Paludrine', but it has been suggested that either by chelating a metal or by nature of the intrinsic size and shape of its cation (there is evidence that it exists as a pseudo-triazole involving a hydrogen-bond) it may possess a structure similar enough to that of the porphyrins to interfere with their metabolism. It is also possible that, as also in the case of the natural antibiotics, discovery of the mode of action of 'Paludrine' may disclose a new essential metabolite.

Had oxine (8-hydroxyquinoline) not already been well known as a chelating agent, the strong antibacterial activity of it and its derivatives might have been difficult to explain, particularly as the lethal action against Gram-positive organisms is far more powerful at low concentrations ($10^{-5}M$) than at higher ones ($3 \times 10^{-3}M$). The hypothesis advanced to explain their action against Gram-positive organisms, and backed by much experimental evidence, is this: at low concentrations the oxine chelates cobalt (cobalt is the only metal which will reverse the inhibition) and thus exposes the bacteria to the action of a second metal which catalyses the oxidation of a chemical group protected by the cobalt. Stronger solutions of oxine protect the organism by removing the injurious metal as well. The second metal has been identified as ferrous iron, and it seems that in the presence of lethal concentrations of oxine the organisms actually die of iron poisoning. Although oxine and its derivatives are not growth-factor analogues, their action is to prevent the normal functioning of essential ions, and a consideration of them is germane to any discussion on chemotherapy. Their mode of action, a disturbance of an existing balance with lethal results to the micro-organism, is worth considering in connexion with other antibacterial agents.

So the biochemist and the chemist, by producing changes in the structure of compounds already known to show a selective toxicity towards the parasite, may produce more and more efficient chemotherapeutic agents. But inevitably, as more is learned of the comparative biochemistry and physiology of micro-organism and potential host, and of those synthetic processes which are more peculiar to the micro-organism, the biologist will seek the closer co-operation of the chemist so that together they may plan, synthesize and test new chemotherapeutic agents.

PARTITION CHROMATOGRAPHY ON PAPER, ITS SCOPE AND APPLICATION

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WITHIN the last twenty years, chromatography has become increasingly important as an analytical tool. The purpose of this article is to review the uses of partition chromatography on paper, which, since its inception four years ago[1], has had a wide application and which promises to become as well established as the older forms of chromatography. It should be emphasized, however, that, as mixtures, especially from biological sources, may be very complex, preliminary separations[2-5] may often be necessary before paper chromatography can be used to the best possible advantage. For recent developments in all types of chromatography, the reader is referred to a number of articles indicated in footnotes 6–9.

Partition chromatography was first developed by Martin and Synge[10] at the laboratories of the Wool Industries Research Association. In this type of chromatogram, separations are achieved because of the differences in partition coefficients between aqueous and non-aqueous phases of the components of a mixture. Using silica gel as the supporting medium for the aqueous phase and eluting with certain water-saturated immiscible organic liquids, separation and estimation of a number of acetyl-amino-acids were effected. This provides a relatively simple and valuable method for the quantitative analysis of some half-a-dozen amino-acids in protein hydrolysates, after acetylation. With the free amino-acids themselves, it was found that owing to their strong adsorption by the silica gel, separations could not be achieved. However, cellulose, in the form of filter paper, was found to be suitable as the stationary support. In this method, a filter paper strip, carrying a mixture of amino-acids (a few micrograms of each) near its upper end, is hung from a trough containing water-saturated solvent (for example, *n*-butanol, phenol, *s*-collidine), the whole system being in an atmosphere saturated with respect to solvent and water vapours. The solvent syphons down the strip, and after a suitable time the amino-acids are revealed by drying the paper and spraying with a solution of ninhydrin and then gently heating. (A simplification of this method—'ascending' chromatography—has been recently reported[11].) It was found that the movement of amino-acids corresponded fairly closely with that calculated from their partition coefficients, thus demonstrating that the cellulose, as in the case of silica gel, acts as an inert support for the aqueous phase. This type of chromatogram is of value because of its simplicity and because many analyses may be carried out on one paper strip, using only very small amounts of material. An early application[12] was to show that *nor*-leucine was not present in spinal cord, as had been originally supposed.

No single solvent has been found which will separate all the common amino-acids on a paper strip; but a more complete separation can be obtained in the 'two-dimensional' technique in which the mixture applied near one corner of a filter paper sheet is chromatographed in one direction with one solvent and then in a direction at right angles with another solvent. The components are thus distributed over the area of a sheet, and by choosing two solvents with different properties, such as *s*-collidine for one direction and phenol for the other, most of the common amino-acids are separated, only ⅓–½ mgm. of protein being required, and all may be separated by additional one-dimensional chromatograms in other solvent systems. On a two-dimensional sheet, the amino-acids occupy characteristic positions, depending on the solvents used, and 'maps'[1,14–17] have been published showing the positions of ninhydrin colouring constituents of biological mixtures.

Ninhydrin has been found to be the best general indicator for the amino-acids as it is very sensitive and little affected by traces of solvents left on the paper after drying. However, as is well known, it is not specific for the amino-acids ; any substance having both free amino- and free carboxyl-groups, such as peptides and non-α-amino-acids, gives colours, while less intense colours are given by nitrogen bases, including amino-acid esters. Though not so sensitive as ninhydrin, β-naphthaquinone sulphonic acid (Folin's reagent) is a useful general indicator, and amino-acids and peptides can be located by their weak fluorescence in ultra-violet light[18]. A number of more specific indicators are available, though, in some cases, thorough removal of solvent from the paper may be necessary, prior to their use. Diazotized sulphanilic acid is an even more sensitive reagent for histidine than ninhydrin. For tryptophan, *p*-dimethylaminobenzaldehyde in acid solution is useful, and with reduced tryptophan, 2 : 4-dinitrophenylpyridinium chloride gives a strong cerise colour. Other useful reagents are potassium iodoplatinate for amino-acids which carry the thio-ether link (for example, methionine and lanthionine), and periodic acid in conjunction with Nessler's solution for the aliphatic hydroxy-amino-acids. The ingenious use of *D*-amino-acid oxidase by Synge (unpublished) for revealing configuration has been applied by Jones[19] to show that the leucine residues of aerosporin have the *D*-form. Dent (private communication) has developed a method for distinguishing between α- and non-α-amino-acids, by removal of the former as their copper complexes ; and the latter, which do not readily form copper complexes, are revealed by ninhydrin.

An early application of the two-dimensional paper chromatogram was by Edman[13], who demonstrated the amino-acids in hypertensin hydrolysates. Modifications of amino-acid residues in a protein after chemical treatment can often be easily observed. Thus, small amounts of lanthionine and cysteic acid have been demonstrated to be present in hydrolysates of wool tips[14], showing that the action of weather and light have modified some of the combined cystine. Cysteic acid has been shown to be present in hydrolysates of wool which had received various oxidizing treatments[3,14], and some destruction of proline and tyrosine has been observed after chlorination of wool. A not unimportant use of paper chromatography is as a control for synthesis[20] and separations[3,21], and to test the purity of substances. Mention should be made of its growing use as a control for various industrial processes involving utilization of amino-acid and peptide mixtures, such as in penicillin and streptomycin production ; but, so far, little has been published in this connexion.

New or unsuspected constituents can be revealed and it is often possible, from its position on the chromatogram, to make a reasonable guess as to the nature of a new substance. For example, Consden, Gordon and Martin (unpublished) observed what was considered to be a weakly basic substance in elastin hydrolysates, and this was confirmed by subsequent electrodialytic experiments. Jones[22] demonstrated the presence of α-γ-diaminobutyric acid in aerosporin, and Borsook *et al.*[23] showed that lysine was metabolized by guinea pig liver to α-aminoadipic acid. Amino-acids, other than the α-variety, and amino-acids not common in animal proteins appear to be widely distributed in plant and bacterial extracts such as α- and γ-amino-butyric acids[15,16]. Indeed, plant extracts offer a vast field for paper chromatography, and already the first reported applications[15,24] have yielded much valuable information, both as regards new constituents and metabolism. The non-protein nitrogen fraction of plants may sometimes contain only relatively few ninhydrin colouring constituents. For example, Consden and Gordon (unpublished) found that an aqueous extract of tea contains only three such substances in strength, namely, aspartic and glutamic acids, and the third, now under investigation, is believed to be a mono ester of glutamic acid. There are obvious applications of paper chromatography in the study of plant extracts to agriculture and animal nutrition.

In the medical field the usefulness of paper chromatography has been shown by Dent[25] in studies of pathological urines and in determining the fate of proteins after digestion[26] ; and there is a great potential use for radioactive isotopes, as is evident from metabolic studies with radioiodine[27], radiocarbon[23], and radiosulphur[28].

There is a fast-growing list of substances other than amino-acids to which paper chromatography is applicable, and which can only be referred to briefly here. An important field was opened up by Partridge[29,30], with the sugars, and the introduction of specific indicators[31] should prove to be particularly useful. Another potentially important field, especially for the study of prosthetic groups, are the flavines[32] and purines[33]. Other substances reported to be separable on paper chromatograms are anthocyanine pigments from petals[34], organic acids[35], adrenalin and related substances[36], creatine and creatinine[37], penicillins[38] and vegetable tannins[39].

Extension to quantitative analysis has enhanced the usefulness of paper chromatography. For many purposes, a rough estimate of a given amino-acid may be usefully made by comparison of the intensity of its ninhydrin spot with that of known amounts of the same amino-acid chromatographed under the same conditions[3,40]. This is clearly capable of industrial application. A refinement of this visual comparison method for both sugars and amino-acids has been reported[41]. The ninhydrin colours themselves have been used for estimations after extraction from the paper[40]. Extraction of amino-acids as their copper complexes, followed by polarographic determination of the copper, has been described[42,43]. This method was used to estimate the five amino-acids produced after hydrolysis of gramicidin S[42]. Alternatively, the copper can be estimated colorimetrically[44], and this method was used by Jones to show that the proportion of leucine to threonine in hydrolysates of aerosporin is 1 : 3 [22]. An interesting isotope dilution method has been described[44a] in which amino-acids are first converted to *p*-iodobenzenesulphonyl derivatives containing radio-active iodine or sulphur and then estimated on paper chromatograms by counting. Quantitative analysis on paper chromatograms of substances other than amino-acids have been devised, notably for sugars and their derivatives[45,46].

Perhaps the most important application of paper chromatography is to elucidate the sequence of amino-acid residues in proteins and polypeptides. This is a problem of fundamental importance, but has long been unsolved because of the lack of methods for handling complicated mixtures of peptides which result from partial hydrolysis ; and, in fact, very few peptides have been isolated and identified[47] by the traditional chemical methods. However, simple peptides behave on paper chromatograms as satisfactorily as amino-acids, and techniques have been devised[4] to separate and identify lower peptides in complex mixtures. The sequence of the amino-acid residues of gramicidin-S was thus established[48] as -(α-valyl) - ornithyl - leucyl - phenylalanyl - prolyl-. Tyrocidin appears to incorporate the sequence -valyl-ornithyl-leucyl- and probably the sequence -aspartyl-glutamyl-tyrosyl- in its structure (Consden, Gordon and Martin, unpublished). There would appear to be a promising field for similar investigations of other polypeptides, the list of which is rapidly growing, consisting of residues of a few varieties of amino-acid or having molecular weights intermediate between simple molecules and proteins.

With the proteins themselves, the mixture arising from partial hydrolysis is likely to be vastly more complex, and it is too much to expect that the structure of a protein could be pieced together from the peptides identified. So far as I am aware, wool is the only protein which has been examined in this way, and preliminary reports have been given by Martin[49] of the identification of nineteen dipeptides of aspartic and glutamic acids[50] and of a number of peptides from the less completely investigated neutral and basic fractions of partial hydrolysates of wool[51]. One conclusion from these studies is that a substantial proportion of the glutamic acid is linked with itself in the wool polypeptide chain. Recently, Consden and Gordon[5] have described techniques for identifying peptides of cystine, and it can be concluded that, in wool, cystine is linked *via* one of its amino-groups and *via* one of its carboxyl-groups to residues of glutamic acid and to residues of most of the neutral amino-acids and that a substantial proportion of proline residues, if not next to, are not far from, cystine residues. The possibility of identifying a large number of peptides in partial hydrolysis mixtures should be a big step forward in our knowledge of protein structure.

It has not been possible to deal adequately here with all aspects of paper chromatography, especially pending publication of the many important developments which are now rapidly taking place. However, enough has been indicated to justify the confident expectation that, before long, this technique will be in common use in many laboratories.

Grateful acknowledgment is made for useful information from Drs. C. E. Dent and A. H. Gordon and to the Director of Research, Wool Industries Research Association, for his interest and advice.

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OBITUARIES

Mr. S. G. Brown, F.R.S.

SYDNEY GEORGE BROWN died on August 6 at Sidmouth, where he went to live on his retirement. He was seventy-five years of age.

Born in Chicago in 1873, his father having gone there to live, he was brought to Great Britain at an early age. He was educated at Harrogate College and University College, London. On leaving college he served as an apprentice in the works of the late Col. Crompton at Chelmsford, where he was principally engaged on calculations and design of dynamos and motors. In 1908 he married Alice Stower, niece of Prof. John Perry, whose close friendship he enjoyed until the time of the latter's death.

It is by his numerous inventions that Mr. Brown became famous. He claimed to have taken out about a thousand patents, commencing when sixteen with a home-made phonograph. In 1899, when only twenty-six years of age, he produced the drum cable relay used in submarine telegraphy. This was followed by the magnetic shunt and other devices connected with duplex working over long-distance cables. Also at this time, with Sir Henry Hozier, he demonstrated a system of directional beam wireless using a parabolic reflector of wire. Signals were transmitted for over a mile between a coastguard station and a lighthouse at Beachy Head. These distances were later increased. This patent was dated 1899.

Finding difficulties in getting his inventions manufactured, he opened in 1910 his own workshops near Liverpool Street, London. After two moves to obtain more space he decided in 1915 to have his own factory built, for which purpose he purchased a large site in Acton, London.

In 1910 he patented his reed type telephone earpiece, by means of which wireless messages could be read when otherwise inaudible. They were adopted as standard by the Royal Navy. He worked on electrical aids for the deaf and was possibly the first to demonstrate bone conduction for hearing. In 1909 he perfected various types of relays for the purpose of amplifying feeble currents both for use in wireless and telephony. This was in the days before the introduction of the thermionic valve. Early in 1914 one of these, the microphone relay, was accepted by the Royal Air Force for use in aeroplanes. By its use wireless messages could be received during flight. The same relays were used by the Admiralty for extending the range of signalling at sea.

Mr. Brown conducted considerable research on rare metals for contact purposes. At the request of the Admiralty he designed the electro megaphone for loudspeaking on warships. One form of this instrument is used on the London Underground Railways for speech between guard and driver. The late Admiral Lord Fisher personally wrote thanking Mr. Brown for his work on relays for detonating mines, using the current from a selenium cell operated by the rays of a searchlight.

The greatest of Mr. Brown's inventions, however, and the one that he himself ranked as his highest achievement, was his gyroscopic compass. The two principal features are the vertical axis and the liquid ballistic. By the first, friction is reduced to a minimum by raising and lowering the whole of the north-seeking parts, including the gyro wheel, at more than a hundred times a minute, using a column of oil, pump-operated. To overcome quadrantal error, common to all gyro compasses, he replaced the solid weight used to precess the compass by a liquid which was free to flow from side to side of the wheel during the rolling of the ship. To work in conjunction with his compass he designed an automatic helmsman which makes it possible to steer a course at sea direct from the compass. He further made a multiple repeater for the ease of steering by hand, also a recorder on which the course of the ship can be plotted on a moving chart. His last invention was a gunnery control compass. This demanded an extreme accuracy at sea only previously associated with a laboratory compass working in a stationary position on land. Such a compass was completed and had passed Admiralty requirements when its adoption was delayed owing to the Second World War making its application impracticable.

With the introduction of broadcasting, Mr. Brown turned his mind to mass production, thousands of pairs of headphones being produced daily. He gave the name to the loudspeaker. While he produced many types fitted with horns he foresaw the development of the large cone diaphragm back in 1910, when he referred to its possibilities in his receiver specification.

During the First World War, Mr. Brown served on the Research Committee for the Detection of Enemy Submarines, the Inventions Board and the Admiralty Ordnance Council. He was elected a fellow of the Royal Society in 1916. In March, 1909, he read a paper before the Royal Institution on "Submarine Telegraphy", and in 1920 one on the "Gyroscopic Compass".

Apart from his activities with the Company that bears his name, he founded and was chairman of the Telegraph Condenser Company.

With all his inventions Mr. Brown acted as his own designer. He was an accomplished engineer capable of giving advice in any department of his works. He was held in great respect by his staff, with whose assistance he earned a great reputation for the high quality of all his work. H. PASMORE

Prof. Marcel Brillouin

THE Nestor of French physics, Marcel Brillouin, formerly professor of physics in the Collège de France, died on June 16 at the age of ninety-four. He belonged to a generation of men of science who could not only master the whole realm of their subject but also make important original contributions to almost every branch of it. As a result they were able to present that subject to their students in a most perfect form, thus providing them with a solid foundation for their own future activities in this field. Prof. Brillouin's lecture courses at the Collège de France provide an outstanding example of this almost extinct art, and many of them have been published in book form, like the well-known "Leçons sur la viscosité des liquides et des gaz".

Like many great physicists, he started as a mathematician at the École normale; but his natural inclination soon diverted him first to mechanics and later to physics as a whole. Thus he acquired skill in the use of mathematics as well as in the handling of apparatus which enabled him to carry out investigations requiring refined experimental and mathematical techniques at the same time, which is so rarely found in physicists of the present generation.

Only a brief indication of Brillouin's most important research subjects can be given here. In hydrodynamics he did fundamental work on the theory of discontinuity surfaces in liquid flow and the formation of vortices on similar lines to Helmholtz, and in aerodynamics he developed a theory of the dispersion of sound. In thermodynamics he devoted himself to the study of permanent deformations of solids and to the specific heat of black body radiation, and he derived the proportionality of this quantity with the third power of absolute temperature. The kinetic theory of matter was enriched by Brillouin's contributions to the theory of diffusion and viscosity in gases and liquids, and he also took part in the once topical controversy on the apparent contradiction in statistical mechanics between the reversibility of the laws of dynamics and the irreversibility of those of thermodynamics. He was very much interested in geophysics as well, and he contributed to this branch of applied physics by papers on the circulation of the atmosphere, the formation of rain, the theory of the tides, etc. An outstanding piece of research in this field consisted in a series of precision measurements of gravity within the Simplon tunnel aiming at a determination of the shape of the 'geoid'. Although naturally his main activity was in the domain of 'classical' physics, he was nevertheless actively interested in the theory of relativity and in quantum theory, where he made an early attempt to give a representation of quantum phenomena in terms of a continuum theory.

It was a source of great satisfaction to Brillouin that the successor to his chair was one of his own sons, Léon Brillouin, who, carrying further the work of his father, has become one of our leading theoretical physicists.

R. FÜRTH

Prof. Beatrice Edgell

THE death of Prof. Beatrice Edgell, professor emeritus in the University of London, takes from us one of the significant figures in the development of British psychology. Born in 1871, she was of the same generation as McDougall and C. S. Myers, with whom she collaborated in the pioneer work of the British Psychological Society and with whom she helped to establish the traditions on which the study of psychology is still based in British universities. Trained first in philosophy at the University College of Wales, Aberystwyth, she turned to experimental psychology and studied at Würzburg, where the use of experimental method was being developed in the study of the processes of thought and judgment. Throughout her life she combined her interests in philosophy and in experimental psychology, though with a special leaning to the latter, and from 1897 until 1933 she was head of the Department of Philosophy and Psychology at Bedford College in the University of London.

At a time when in many universities psychology was at best a subordinate partner of philosophy, her position as professor of psychology in charge of both subjects was unusual. The laboratory she established bears witness to her concern for exact and objective experimental method aided by the best material equipment then available. Her chief publications ("Theories of Memory" (1924), "Mental Life" (1926) and "Ethical Problems" (1929)) indicate the two sides of her interest, as does the fact of her contributing both to psychological journals and to the *Proceedings of the Aristotelian Society*. Her example and influence thus aided the development of psychology in Britain as an independent experimental science which still retained the stabilizing effect of philosophical discipline. Her psychological interests centred largely on the cognitive aspect of mental experience, especially memory and perception, and she also paid particular attention to the experimental approach to æsthetics. As a teacher, however, she was stimulating over a wider range. "Ethical Problems" was written specially with the view of helping nurses, and her text-book, "Mental Life", was intended for students preparing for social work. Precise of mind and emphatic of utterance she was an excellent teacher, and she is held in affectionate respect by a large number of former students, many of whom are now engaged in psychological work applied to industry, education and various branches of social work.

In her retirement Prof. Edgell still occupied herself with psychology, including its newer developments. She was recently, for example, using the Rorschach test with critical appreciation. She continued to help students, and to take an active interest in the British Psychological Society, of which she was a past president and honorary fellow. During the War she wrote a history of the Society, part of which she read at the annual meeting of the Society in 1946. This was the first occasion on which many of her younger colleagues had met her, and they will remember her as they saw her then, frail, alert and indomitable.

NEWS and VIEWS

Psychological Medicine in Glasgow: Prof. T. Ferguson Rodger

DR. T. FERGUSON RODGER has been chosen as the first occupant of the newly founded chair of psychological medicine in the University of Glasgow. Dr. Rodger graduated in science and medicine at Glasgow in 1927–29 and holds the diploma in psychological medicine of the University of London. During 1931–32 he worked at Johns Hopkins University, where he was a pupil of Adolf Meyer. From 1933 until 1939 he was senior assistant at Glasgow Royal Mental Hospital (Gartnavel), and an assistant to the lecturer in psychiatry in the University. Throughout the War he served in the Royal Army Medical Corps as consulting psychiatrist at Headquarters, Land Forces, South-East Asia, and at General Headquarters, India. Latterly, he has been a commissioner of the General Board of Control (which functions under the Lunacy, Mental Treatment and Mental Deficiency Acts). Dr. Rodger has specialized in psychosomatic medicine. He was responsible for research into the methods of selecting officers for the army. He has also published work on fibrositis and on night-blindness.

Pathology in Glasgow: Prof. G. L. Montgomery

GEORGE LIGHTBODY MONTGOMERY has been appointed to the St. Mungo-Notman chair of pathology (associated with the Royal Infirmary, Glasgow) in succession to Prof. John W. S. Blacklock, who has moved to St. Bartholomew's Hospital, London. Prof. Montgomery graduated at Glasgow (M.B., Ch.B., 1928; M.D., 1946), and also holds the Ph.D. degree of the University of St. Andrews (1936). After holding appointments at Glasgow Royal Infirmary, in 1931 he became lecturer in clinical pathology at St. Andrews and assistant pathologist at Dundee Royal Infirmary. Since 1937 he has been Gardiner research lecturer in the pathology of disease in infancy and childhood in the University of Glasgow, and pathologist at the Royal Hospital for Sick Children, Yorkhill. During almost the whole of the

War he served on the Directorate of Pathology at home, in the Central Mediterranean and in South-East Asia. His researches include work on the renal function in various morbid states, on diseases of childhood (with special reference to non-tubercular infections of the lung), and on the healing of lung injuries. He has recently taken part in the trials of streptomycin carried out by the Medical Research Council.

Victor Meyer (1848–97)

Among the many eminent German chemists of the latter half of last century, none enjoyed a higher reputation than Victor Meyer, who entered the University of Heidelberg in 1865 at the age of seventeen and, twenty-four years later, was chosen to succeed his old master Bunsen in the chair of chemistry there. Meyer was born at Berlin on September 8, 1848, being the son of a Jewish calico manufacturer. His home influences had tended towards the literary and artistic rather than the scientific, and Meyer, it is said, wished to become an actor, for which he had all the natural gifts. At Heidelberg, however, he came under the spell of Kopp, Kirchhoff, Helmholtz and Bunsen, and after a time became assistant to the last. From Heidelberg he went to Berlin to work under Baeyer, and successively held posts at Stuttgart, Zurich and Göttingen, before returning to his *alma mater*. With a fine voice, handsome presence and impressive manner, he became known as one of the best lecturers in Germany. With his other gifts he combined a passion for work, and was responsible for some three hundred memoirs. His most important investigations are referred to in the Memorial Lecture on Meyer delivered to the Chemical Society on February 8, 1900, by Sir Edward Thorpe, who had known him for thirty years. Unfortunately, his great mental activity brought on insomnia and he had several spells of ill-health. His death took place on August 8, 1897, when he was but forty-eight years of age. He had received many honours from scientific societies, and among these was a Royal Medal from the Royal Society awarded him two years after he had succeeded Bunsen.

Dedication of Private Woodlands

In the Forestry Commission Booklet No. 2 (H.M. Stationery Office, London, 1948) the purpose of the scheme for the dedication of private woodlands is explained. This purpose is to encourage the application of systematic management to private woodlands, become necessary, it is said, in the interests of national security because the reserves of standing timber have been greatly depleted during and since the War; and it might be added are still suffering from more or less crude over-felling, especially in the hardwood areas. Under the scheme the owner undertakes to use the land in such a way that timber production is the main object; to work to a plan to be approved by the Forestry Commission; to employ skilled supervision, and to keep adequate accounts. The object of the scheme is to ensure that replanting or regeneration of woodlands cut during the War shall proceed with continuity and rapidity, that this work in its young stages must be looked after until the young woods are established and, it is to be proposed, after that stage has been reached. Owners must make up their minds as to whether they are prepared to work the scheme; if they agree, they will receive State financial assistance. If the owner is unwilling to join the scheme or keep his woodland areas in proper order, the State will acquire them. Finally, some system of control of the sylviculture of private woodlands is deemed necessary.

To give effect to the scheme a deed of covenant in England and Wales and an agreement in Scotland will be entered into by which both the State and the owner undertake respective obligations as already mentioned. The Forestry Commission, as the agent of Government, will undertake to provide financial assistance to the owner on one of these bases at the owner's option: (1) To repay to the owner 25 per cent of the approved net annual expenditure on a dedicated woodland by way of loans which are described in the pamphlet. (2) To make payment to the owner as follows: (*a*) a planting grant of £10 per annum for every acre planted or replanted, softwood or hardwood, after date of dedication; (*b*) loans in addition to (*a*) on terms to be settled according to individual circumstances, the terms being given in the pamphlet; (*c*) a maintenance grant for fifteen years of 3*s*. 4*d*. per acre per annum on every acre dedicated that is planted properly and maintained; (*d*) a maintenance grant for fifteen years of 3*s*. 4*d*. per acre per annum from the date of dedication, on all productive woodlands other than new plantations covered already by (*c*) and (*d*). These grants will be reviewed and revised as may be necessary after five years from 1946–47 on the basis of ascertained costs. Dedication will run with the land and will not be affected by change in ownership.

New German Hydrographic Journal

With the first issue of the *Deutsche Hydrographische Zeitschrift* (1, No. 1, January, 1948), to the forthcoming appearance of which reference was made in *Nature* of August 16, 1947, p. 219, the publication of post-war articles by German oceanographers and other marine scientists and technicians commences. The first paper, by K. Kalle, deals with the problem of marine production and reviews research material and methods of investigation. Kalle compares the probable amount of marine production with the yields known from continental soils of the temperate zones. W. Hansen in the second article gives a general mathematical treatment of the oscillations of inertia in open and land-locked seas. The old nautical problem of the dip of the horizon is attacked once more theoretically, by H. Chr. Freiesleben. He derives a formula which, in order to be strictly employed, demands measurements of the air-temperature at the horizon immediately above the sea-surface. Another short but interesting contribution, by F. Errulat, describes a series of measurements of the earth-magnetic field on the Dacia Bank (between Madeira and Morocco); he concludes that the Bank has a core of eruptive rocks. The field of nautical technique is represented by a description of a direction-holder named "Polkreisel", by P. Christoph. Moreover, there is an article on the German Hydrographic Institute, its origin, its tasks, and its organisation by the director, Dr. Böhnecke, and finally there are obituary notes on several notable German scientists who had worked on nautical science and on oceanography. In the next issue (No. 2/3) of the *Zeitschrift*, which was expected to be distributed in the beginning of August 1948, there is to be (with other papers) articles on the bottom geology of the southern and middle Baltic, on a fundamental geodetic problem in sea-surveying, on magnetic storms, and on resonance oscillations of bights and the mouth correction for seiches.

Trade Unions in Industry

As part of a general production drive, the Trades Union Congress is inviting trade unionists to extend their knowledge of management in industry. Through its publicity organ *Industrial News*, the Congress has announced that it is co-operating with the National Institute of Industrial Psychology, the British Institute of Management, the Government Committee on Industrial Productivity and the Administrative Staff College in seeking ways to make workshops more happy and efficient places. Experiments are to be carried out on the problems of the effects of boredom in industry, the means of minimizing labour turnover and the training of new employees. The Trades Union Congress is asking members of trade unions to co-operate with these organisations by seeking goodwill for their officers at places suitable for experiment.

Cultivation of Root Vegetables

Bulletin No. 120 of the Ministry of Agriculture and Fisheries (H.M. Stationery Office. 9*d.* net) deals with all phases of the commercial cultivation of carrots, beetroot, parsnips, turnips, swedes and other minor root crops. A new revision (August 1947) of the third edition has recently appeared, and brings the subject-matter up to date. The most modern additions deal with row-crop cultivation, irrigation, and the control of weeds.

Precession of an Unsymmetrical Top

It has been known since the time of Lagrange's "Mécanique Analytique" (1788) that a rigid body smoothly pivoted at one of its points O and symmetrical about an axis passing through O can have steady motions of precession in which the axis of symmetry rotates uniformly about the vertical while the solid itself rotates uniformly about the axis of symmetry; but it has been generally supposed that there is no corresponding result if the body is unsymmetrical. However, G. Grioli (*Annali di Mathematica*, **26**, 1; 1947, and *Rendiconti dell' Accademia Nazionale dei Lincei*, **4**, 420; 1948) has shown that under certain conditions we can have steady precession of an unsymmetrical body about a non-vertical axis. If G is the centre of mass, it is necessary that OG should be perpendicular to one of the two circular sections of the momental ellipsoid at G, and that the axis of precession should be inclined to the vertical at a definite angle which can be calculated from the same momental ellipsoid. If these conditions are satisfied, there is a doubly infinite set of motions in which OG is perpendicular to the axis of precession, and the solid rotates uniformly about OG in the same time as OG rotates uniformly about the non-vertical axis of precession.

Geotectonic Map of North-west Germany

Last year the first German publication on scientific geology since the War was issued by the Reichsamt der Bodenforschung, Hanover, namely, a general geotectonic map of north-west Germany, scale 1 : 100,000 (15 sheets, 200 marks). This map comprises all wells and geological as well as geophysical results from 1934 up to 1945. The new map is supplemented by formation data, stratigraphic symbols, profiles, surface contour lines, data of the depths, and geophysical data. Moreover, there is attached a general map, scale 1 : 1,000,000, of the structures and two hundred salt domes in this area. A volume of annotations of the map is projected.

Society for Visiting Scientists

The Society for Visiting Scientists (5 Old Burlington Street, London, W.1) has been able to extend its facilities and membership for scientific workers resident in the United Kingdom. The number of such members is no longer limited, and applications for membership from scientific workers interested in the Society's aims will be welcomed by the Executive Committee. Applicants should apply to the Assistant Secretary, mentioning one or more members of the Society who would be willing to be their sponsors. The subscription for members resident in the United Kingdom is three guineas per annum, with an entrance fee of one guinea. Visiting scientists from overseas are charged an entrance fee of five shillings only, and pay an annual subscription only if they reside in the United Kingdom for more than six months. The Society now has more than 1,300 members, about 1,170 of whom are overseas. In addition to the opportunity of meeting visiting scientists, and thus furthering international contact and friendship among men of science, the Society's premises offer useful club facilities.

National Foundation for Scientific Research, Brussels

The twentieth annual report of the National Foundation for Scientific Research, Brussels, for the year 1946–47, gives lists of members of the various commissions, and a note on the Inter-University Institute of Nuclear Physics. It also includes full details of the forty-five research grants made for the year 1947–48, amounting to 2,062,500 francs, and an analysis of the distribution of grants made since the establishment of the Foundation. Special grants for the period 1947–48 have been allotted to M. Biquet for sinking wells in water-bearing strata for the study of the freezing of dead ground at great depths (150,000 francs); to Prof. F. Mayence for excavation at Apamée (100,000 francs); to MM. Gratia, Florkin, Massart and Desreux for completing the existing installation of apparatus for electrophoresis by a high-quality optical apparatus of the Klett or Pearson type (100,000 francs); and to Prof. Piccard and Prof. Cosyns for submarine investigations at great depths. A list of publications during the year by those receiving grants during 1945–47, arranged under authors' names, is appended.

International Union of Crystallography

The first General Assembly and Congress of the recently formed International Union of Crystallography was held at Harvard University, Cambridge, Mass., during July 28–August 3 and was attended by some 350 crystallographers of ten nations. In recognition of his epoch-making contribution to the modern development of the subject, Prof. M. von Laue (Germany) was unanimously elected honorary president of the Union. Officers were elected as follows: *President*, Sir Lawrence Bragg (Great Britain); *Vice-Presidents*, A. Westgren (Sweden), R. W. G. Wyckoff (United States); *General Secretary*, R. C. Evans (Crystallographic Laboratory, Cavendish Laboratory, Cambridge); other members of the Executive Committee are M. J. Buerger (United States), P. P. Ewald (Great Britain), A. L. Patterson (United States), J. Wyart (France). Statutes and by-laws of the Union were adopted, and the adhesion of Great Britain, the United States, Canada and Norway was recognized. Commissions of the Union were established as follows : *Acta Crystallographica*, International Tables, Structure Reports, Crystallographic Apparatus, Nomenclature, Crystallographic Data. Crystallographers throughout the world interested in the work of any of these Commissions are invited to make contact with them through the General Secretary. The second General Assembly and Congress will be held in Europe during the summer of 1951.

Mechanization of African Agriculture

PROBLEMS likely to be encountered in the mechanization of African agriculture are to be studied by a mission which is visiting Uganda, Tanganyika, Nyasaland and Nigeria. The leader is Dr. J. R. Raeburn, of the Agricultural Economics Research Institute, Oxford, and he is accompanied by Mr. J. W. Y. Higgs, lecturer in agricultural economics, University of Reading, and Mr. R. K. Kerkham, Uganda Agricultural Service, who is at present stationed at the Uganda Agricultural Research Station. The terms of reference are : "To make a systematic survey of the sociological, economic, agricultural and technical problems which must be studied if mechanization of agriculture in the Colonies is to develop along sound lines, including *inter alia* the forms or organization required to achieve the best results (for example, whether mechanization should be on a co-operative, group or peasant basis), the most profitable lines of future research into problems arising out of mechanization, the economics of it and the types of tractors and implements which would be likely to be most suitable to the differing African communities, and such questions as the technical training of African craftsmen, the division and displacement of labour which will result from mechanization and its impact on current farming and social systems."

Colonial Service Appointments

THE following appointments in the Colonial Service have been announced : A. Bolton, plant breeder, Kenya ; E. A. Rosenquist, botanist, Malaya ; J. A. F. Gerrard, geophysicist, Uganda ; A. D. Campbell, veterinary officer, Nigeria ; D. W. D'Silva, assistant conservator of forests, British Honduras ; H. T. Hayes, fisheries officer, Gold Coast ; G. H. Lunam, fisheries officer, Nigeria ; D. M. Rhodes, fisheries officer, Uganda ; O. E. Symes, fisheries development officer, Nigeria ; T. R. Hayes (principal agricultural officer, Uganda), assistant director of agriculture, Uganda ; R. B. Jagoe (botanist, Federation of Malaya), senior botanist, Federation of Malaya ; H. T. Pagden (entomologist, Federation of Malaya), senior entomologist, Federation of Malaya ; D. H. Welsh (agricultural officer, Nigeria), principal of schools, Agricultural Department, Nigeria ; D. B. Fanshawe (assistant conservator of forests, British Guiana), senior assistant conservator of forests, British Guiana.

Effect of Lightning Discharge

PROF. E. W. MARCHANT, 20, Harthill Road, Liverpool, 18, writes : "During a severe thunderstorm in Liverpool on July 31, the centre of the roadway was struck by lightning. The lightning discharge produced a crack about six feet long in the asphalte road surface near the centre of the road and close to a manhole cover, which, I understand, was open at the time of the storm. Six or seven pieces of melted tar were scattered over the road close to the crack. Heavy rain was falling at the time and the interesting thing about the discharge was that it struck the flat surface of the road, although, only thirty feet away on each side, were trees about twenty feet high."

Announcements

DR. ANDRÉ DANJON, director of the Paris Observatory, has been elected a member of the Section of Astronomy of the Paris Academy of Sciences, in succession to the late Dr. Henri Deslandres.

DR. W. A. MACFARLANE, director of fuel efficiency in the Ministry of Fuel and Power, has been lent by the Ministry to the Department of Scientific and Industrial Research for about two years for appointment as director of the United Kingdom Scientific Mission in the British Commonwealth Scientific Offices in Washington. He will also be attaché for scientific matters in the British Embassy. In accordance with arrangements made at the time of his appointment, the present director of the Mission, Dr. F. N. Woodward, is returning to the United Kingdom towards the end of the year.

THE Public Health and Municipal Engineering Congress and Exhibition will be held at Olympia, London, during November 15–20. Further information can be obtained from the Joint Hon. Secretary, 84 Eccleston Square, London, S.W.1.

THE twenty-third annual conference of the Association of Special Libraries and Information Bureaux (ASLIB) will be held at Ashorne Hill, near Leamington Spa, Warwickshire, during September 17–20. Further information can be obtained from the Secretary, ASLIB, 52 Bloomsbury Street, London, W.C.1.

THE Council of the Royal Society of Arts is offering, under the Thomas Gray Memorial Trust, the objects of which are "the Advancement of the Science of Navigation and the Scientific and Educational interests of the British Mercantile Marine", a prize of £50 for an essay on "The Applications of Radar to Navigation". Further information can be obtained from the Secretary, Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2.

The South African Journal of Science of March 1948 reports the Oudtshoorn meeting in July 1947 of the South African Association for the Advancement of Science. It includes the presidential address by Prof. H. H. Paine, "The World View of the Physicist", and the addresses of the sectional presidents. Of these, Prof. C. C. Gillie reviewed "A Century of Astrophysics", Dr. C. N. C. Hamilton dealt with "Coal", Prof. A. Quintanilha with "The Problem of Cotton Production in Portuguese Africa", Dr. C. S. Grobbelaar with "Anthropometry and its Role in South Africa", the Abbé H. Breuil with "Ancient Raised Beaches and Prehistoric Civilizations in South Africa", and J. D. Rheinallt Jones with "The Development of Central and Southern Africa", including a few suggestions for research and action on some of the problems common to these territories. A number of the papers read at the meeting are also printed.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Mechanism of the Oxidation of Gaseous Formaldehyde

RECENTLY, Axford and Norrish[1] have put forward a scheme for the oxidation of gaseous formaldehyde in the temperature range 325°–375° C. Though this scheme accounts for the experimental facts, we regard the proposed initiation reactions as unsatisfactory, for they suggest that formaldehyde is oxidized directly to formic acid, whereas it is highly probable that this does not take place in a single step. Our recent experiments on the oxidation of gaseous acetaldehyde[2] have led us to propose as an initiation process the reaction of an oxygen molecule with an acetaldehyde molecule to form the acetyl radical and the perhydroxyl radical (HO_2). If an analogous initiation reaction is postulated for the oxidation of formaldehyde, we have

$$HCHO + O_2 = HCO + HO_2.$$

The formyl radical is thought to be unstable[3,4] above 100° C., and it can reasonably be assumed that at high temperatures it will split up rapidly to give carbon monoxide and hydrogen. Then our first step becomes

$$1.\ HCHO + O_2 = H + CO + HO_2 \quad k_1 \text{ initiation.}$$

The subsequent reactions we suppose to be the same as those put forward by Axford and Norrish,

$$\begin{array}{lll} 2. & H + HCHO = H_2 + CO + H & k_2 \text{ propagation-decomposition} \end{array}$$

$$\left.\begin{array}{lll} 3. & H + O_2 + HCHO = H_2O + CO + OH & k_3 \\ 4. & OH + HCHO = H_2O + CO + H & k_4 \\ 5. & H + O_2 + HCHO = H_2O + CO_2 + H & k_5 \end{array}\right\} \text{propagation-oxidation}$$

$$\left.\begin{array}{lll} 6. & H + O_2 + X = HO_2 + X & k_6 \\ 7. & H + O_2 + O_2 = HO_2 + O_2 & k_7 \\ 8. & H + O_2 + \text{wall} = HO_2 & k_8 \end{array}\right\} \text{termination}$$

Since the chains are started by reaction (1) and terminated only by reactions (6), (7) and (8) we have, following Axford and Norrish[1]:

$$k_1(O_2)(HCHO) = k_6(H)(O_2)(X) + k_7(H)(O_2)^2 + k_8(H)(O_2)(S)/d$$

(for cylindrical vessels the ratio area/volume is $1/d$, approximately, so if (S) represents the surface activity per sq. cm., then $(S)/d$ is the surface activity per unit volume). From this we get

$$(H) = \frac{k_1(HCHO)}{k_6(X) + k_7(O_2) + k_8(S)/d}. \tag{9}$$

For the equilibrium concentration of OH radicals we have

$$k_3(H)(O_2)(HCHO) = k_4(OH)(HCHO).$$

Hence

$$(OH) = k_3 \frac{(H)(O_2)}{k_4}. \tag{10}$$

Substituting for (H) from (9) into (10) we get

$$(OH) = \frac{k_1\, k_3\, (O_2)(HCHO)}{k_4\{k_6(X)+k_7(O_2)+k_8(S)/d\}}. \tag{11}$$

The rate of disappearance of formaldehyde is, therefore, given by

$$-\frac{d(HCHO)}{dt} = k_1(HCHO)(O_2) + k_2(H)(HCHO) + (k_3+k_5)(H)(O_2)(HCHO)+k_4(OH)(HCHO). \tag{12}$$

Substituting for (H) and (OH) from equations (9) and (11) we get

$$-\frac{d(HCHO)}{dt} = k_1(HCHO)(O_2) + \frac{k_1k_2(HCHO)^2}{k_6(X)+k_7(O_2)+k_8(S)/d} + \frac{k_1(O_2)(HCHO)^2(2k_3+k_5)}{k_6(X)+k_7(O_2)+k_8(S)/d}. \tag{13}$$

This is the same as equation (IV) given by Axford and Norrish on page 534 of their paper[1]; thus this modified scheme, also, accounts for the experimental results. It has, however, the advantage of a more clear-cut initiation step and also shows why one gets performic acid at low temperatures, for here the formyl radical will be stable and the following reactions can take place.

$$\begin{array}{llll} HCHO & + O_2 & = HCO + HO_2. & (14) \\ HCO & + O_2 & = HCOOO. & (15) \\ HCOOO & + HCHO & = HCOOOH + HCO. & (16) \end{array}$$

This is analogous to the scheme which we are putting forward to explain the occurrence of peracetic acid in the low-temperature oxidation of acetaldehyde.

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April 13.

[1] Axford, D. W. E., and Norrish, R. G. W., *Nature*, **160**, 537 (1947); *Proc. Roy. Soc.*, A, **192**, 518 (1947).

[2] McDowell, C. A., and Thomas, J. H. (unpublished experiments).

[3] Akeroyd, E. I., and Norrish, R. G. W., *J. Chem. Soc.*, 890 (1936).

[4] Leermakers, J. A., *J. Amer. Chem. Soc.*, **56**, 1537 (1934).

ANY initiation process which will provide one of the chain centres responsible for the propagation reaction, and the rate of which depends upon the product of the pressures of formaldehyde and oxygen, may be substituted for that which we propose without change in the structure of the kinetics. It is thus not surprising that there is no formal change in the derivation of the relationship which Messrs. McDowell and Thomas reproduce from our paper. Initiation reactions, however, can be distinguished by studying the overall activation energy of the chain reactions which they initiate and to which they make the principal contribution, and in choosing the most likely initiation reaction, reference must be made to the thermochemistry of the processes postulated. Now the overall temperature coefficient of the oxidation of formaldehyde at 350° C. indicates an energy of activation of about 20 k.cal., and nearly all of this is associated with the initiating process, for which the velocity coefficient is k_1. Thus the initiation process at the temperature studied cannot be more endothermic than *c.* 20 k.cal., and is probably less so. From the data of Bray[1] we may derive

$$H + O_2 = HO_2 + 52 \text{ k.cal.};$$

and combining this with

$$H + HCO = H_2CO + 102 \text{ k.cal.},$$

we may calculate that the reaction

$$H_2CO + O_2 = HCO + O_2$$

is endothermic to the extent of 50 k.cal. Since this figure must give a lower limit for the energy of activation, it would appear that the reaction cannot function as an initiating process for the formaldehyde oxidation in the range of temperature where the overall energy of activation is 20 k.cal.

On the other hand, from the heats of combustion of formaldehyde and formic acid, and the heat of dissociation of molecular oxygen, we may calculate a heat absorption of about 8 k.cal. for the initiation process:

$$HCHO + O_2 = (HCOOOH) = HCOOH + O$$

postulated by us. This endothermicity is less than the energy of activation at 350° C. and is thus in accord with the experimental results.

Our initiation reaction involves the formation of performic acid as a transition compound, followed by its decomposition to give an oxygen atom; this would explain the occurrence of performic acid at the lower temperatures at which it is stable, and a similar scheme would give peracetic acid in the case of acetaldehyde. We have never supposed that the reaction takes place in a single step as suggested by Messrs. McDowell and Thomas. On the other hand, there is no case for dogmatizing, and we hope to get further evidence from a more detailed study of the temperature coefficient of the reaction. There are reasons for believing that more than one initiation reaction can operate, each in a different temperature range, without essentially changing the kinetic scheme we have derived, and at higher temperatures the alternative which has been suggested is not excluded.

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[1] Bray, *J. Amer. Chem. Soc.*, 60, 82 (1938). See also Rollefson, "Photochemistry", 276 (Prentice-Hall, 1939).

Further Experimental Evidence for the Theory of Quasi-Properties

Scott Blair, Veinoglou and Caffyn[1] have explained the rheological behaviour of certain complex materials in terms of 'quasi-properties'; that is, complex entities in which a number of magnitudes taken together describes the process which the material undergoes as a result of a specified test, the ordinary 'properties', such as viscosity and elasticity, being changed by the testing process itself.

The simplest illustration of this is the Nutting[2] equation

$$\psi = S^{\beta}\sigma^{-1}t^{k}, \qquad (1)$$

where S is stress, σ is strain, t is time, and where ψ is a constant which can only describe the relative behaviour of materials when quoted in conjunction with k and β, which are numbers specifying its dimensions. In the limit, when β and k have constant values for large groups of materials, ψ approximates in character to a physical property of the ordinary kind.

Many materials subjected to constant compressive or tensile stresses or relaxing at constant strain after rapid straining accurately obey equation (1); but a few, especially when relaxation follows a slow straining, show considerable discrepancies.

In our earlier paper* we proposed 'intermediate' fractional differential equations of the type:

$$\text{Proto-}\atop\text{types}\left\{\begin{array}{l}\left.\begin{array}{l}\eta = S \div \dfrac{d\sigma}{dt}\\ n = S \div \sigma\end{array}\right\}\chi_1 = S^{\beta} \div \left|\overline{\dfrac{\partial^{\mu}\sigma}{\partial t^{\mu}}}\right. \\ \qquad\qquad\qquad\qquad (2a) \\ \left.\begin{array}{l}\eta = t \div \dfrac{d\sigma}{dS}\\ \pi = t \div \dfrac{\sigma}{S}\end{array}\right\}\chi_2 = t^{k} \div \left|\overline{\dfrac{\partial^{\omega}\sigma}{\partial S^{\omega}}}\right. \\ \qquad\qquad\qquad\qquad (2b)\end{array}\right\}\frac{1}{X} = \left|\overline{\frac{d^{\mu+\omega}\sigma}{dt^{\mu}.dS^{\omega}}}\right. \qquad (2)$$

where $\lceil$ indicates fractional differentiation. Equation (2*a*) may be integrated to give:

$$\sigma = At^{k} + Bt^{k-1} + Ct^{k-2}, \qquad (3a)$$

and it was shown that the great majority of those of our data which did not obey equation (1) could be accounted for by introducing the second term of equation (3*a*) and, in a few cases, the third term.

We have now examined the rest of the anomalous data and have fitted both the integrated form of equation (2*b*):

$$\sigma = A'S^{\beta} + B'S^{\beta-1} \qquad (3b)$$

as well as the general integrated form of equation (2):

$$\sigma = (At^{k} + Bt^{k-1}\ldots)(A'S^{\beta} + B'S^{\beta-1}\ldots). \qquad (3)$$

(The product is preferred to the sum of equations (3*a*) and (3*b*), though both are valid integrations of equation (2).)

In all the data examined, we have found that with no more than two terms in each case, either equation (3*a*), (3*b*) or (3) fits our data within the limits of experimental error, which are satisfactorily low.

Since the ratios B/A and B'/A' have the dimensions of time and stress respectively and represent characteristics of the materials, it should be possible to write the three equations in dimensionless form by expressing all times and stresses in terms of these characteristics. Deviations from the simple Nutting equation are rarely large enough, however, for such a procedure to give reasonable accuracy.

In our earlier paper we explained that the fractional differentials with respect to time arise as a result of the use of the Newtonian definition of equality of time units, the acceptance of which *defines* the velocity of light, or of bodies free from the influence of other matter as constant.

Just as the Newtonian time-scale depends on the constancy of the magnitude of such velocities, so it seems that Newtonian definitions of equality of forces, unless directly involving Newtonian time, must depend on the concept of a straight line or of unchanging direction, that is, the *course* of a light ray or of a body uninfluenced by other matter.

For example, two forces, X and Y, might be defined as equal when, acting in the same direction on a body, a third force, Z, can be found which would balance either of them so that the body would not change its motion as a result of the simultaneous actions of either X–Z or Y–Z. If the body is of finite size, X (or Y) and Z must be acting in a straight line: if the body becomes a point, there can be no change in direction at this point.

The implications of this in relation to the stress fractional differentials (equations 2*b* and 3*b*) are discussed in a paper in process of publication (*Phil. Mag.*), in which the full experimental results are also given.

Our indebtedness to several colleagues who have helped us is expressed in our paper itself. Here we wish to acknowledge our gratitude to the British

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* The equations are here re-written in a slightly more convenient form.

Electrical Research Association for permission to publish this work, to the Agricultural Research Council for a grant to one of us (J. E. C.), and to Dr. L. J. Comrie for most of the calculations.

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May 4.

[1] Scott Blair, G. W., Veinoglou, B. C., and Caffyn, J. E., *Proc. Roy. Soc.*, A, **189**, 69 (1947).

[2] Nutting, P. G., *J. Franklin Inst.*, **191**, 679 (1921).

Ionic Reactions in Liquid Dinitrogen Tetroxide

The fact that liquids other than water may serve as media for inorganic reactions is widely recognized ; reactions in the well-known liquid ammonia and liquid sulphur dioxide systems are explained by postulating the ionization :

$$2NH_3 \rightleftharpoons NH_4^+ + NH_2^-$$

$$2SO_2 \rightleftharpoons SO^{2+} + SO_3^{2-},$$

although neither liquid has an appreciable electrical conductivity. Frankland and Farmer[1] in 1901 first considered the possibility that liquid dinitrogen tetroxide might serve as an ionizing medium, but were unable to find any inorganic salt which was soluble in the liquid. In view of the high solubility of many organic compounds, they concluded that the liquid was of a non-ionizing character and resembled in behaviour such organic solvents as benzene.

We have now obtained evidence that ionic reactions can be conducted in liquid dinitrogen tetroxide medium. Where electron-transfer can readily occur, all reactions so far investigated in this medium can be interpreted on the basis of the ionization :

$$N_2O_4 \rightleftharpoons NO^+ + NO_3^-. \qquad (1)$$

The existence of the nitrosyl radical is already established in other media[2,3], and we have found no evidence for dissociation of the N_2O_4 into NO_2^+ and NO_2^- under these conditions. Thus the alkali metals, including lithium, react rapidly but quietly with liquid dinitrogen tetroxide to yield the nitrate and nitric oxide :

$$Na + N_2O_4 \rightarrow NaNO_3 + NO. \qquad (2)$$

The reaction is not affected, except in velocity, by dilution of the dinitrogen tetroxide with an inert solvent such as benzene. The insoluble nitrate produced is free from nitrite. At temperatures approaching the boiling point of dinitrogen tetroxide (21·3°) the nitric oxide is evolved (although at low temperatures, or under pressure, some nitric oxide remains associated in the liquid phase as blue dinitrogen trioxide), and the reaction can be considered as a simple electron transfer from the sodium atom to the NO^+ ion, giving the resonance-stabilized nitric oxide molecule. Attempts to explain this reaction on the basis of dissociation of the medium into NO_2^+ and NO_2^- would involve the intermediate formation of the alkali metal nitrite, which we have found to be stable in contact with liquid dinitrogen tetroxide. Although some metallic oxides when allowed to react with dinitrogen tetroxide yield nitrite as well as nitrate, this is probably at least a two-stage reaction which may be explained thus :

$$MO + (2NO^+ + 2NO_3^-) \rightarrow M(NO_3)_2 + 2NO^+ + O^{2-},$$

followed by $MO + 2NO^+ + O^{2-} \rightarrow M(NO_2)_2$, and the formation of nitrite here does not necessarily imply the presence of NO_2^- in the medium.

Ammonium chloride (in liquid ammonia) and thionyl chloride (in liquid sulphur dioxide) have many properties commonly associated with aqueous hydrochloric acid solutions. The corresponding compound in the liquid dinitrogen tetroxide system, nitrosyl chloride, is soluble in this medium and such solutions attack many of the metals which are resistant to the tetroxide alone, the degree of attack depending on the concentration of the nitrosyl chloride ; nitric oxide is evolved, the insoluble product being either the metal chloride or the chloride associated with nitrosyl chloride as a complex of the type $(NO)_x[MCl_y]$.

The ionic dissociation of dinitrogen tetroxide (equation 1) is fully reversible in the liquid phase. Thus the reaction :

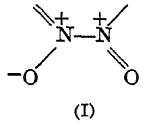
$$NOCl(\text{in } N_2O_4) + AgNO_3(s) \rightarrow AgCl(s) + N_2O_4(l)$$

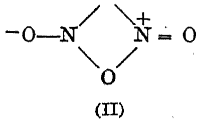
(comparable with the reaction between an aqueous solution of hydrogen chloride and an insoluble hydroxide) is complete in the direction indicated. However, if dry diethylammonium chloride is added to liquid dinitrogen tetroxide at 0° the reaction :

$$[Et_2NH_2]^+Cl^- + N_2O_4 \rightarrow NOCl + [Et_2NH_2]^+NO_3^- \qquad (3)$$

proceeds readily. The medium is immediately coloured red by the nitrosyl chloride produced, and diethylammonium nitrate may be crystallized from the solution ; the process resembles that of hydrolysis. At higher temperatures the products of reaction (3) undergo further mutual interaction.

Full details of the work will be published elsewhere, but it is of interest here to compare the behaviour of dinitrogen tetroxide outlined above with its reactions where bonds of a covalent character are involved. Levy and Scaife[4] have shown that it adds to olefinic double bonds to give exclusively dinitro-compounds or nitro-nitrites. Again, both ammonia and diethylamine react explosively with it, yet ammonium and diethylammonium chlorides and nitrates are unattacked, so that the conversion of the base into the ionic form shields it from decomposition by dinitrogen tetroxide. We are led to the conclusion that the dinitrogen tetroxide molecule may undergo dissociation in two ways during reaction, giving either $(NO^+ + NO_3^-)$ or $(NO_2^+ + NO_2^-)$, and that the particular course followed depends upon whether the reacting groups are charged ions or covalent, uncharged molecules. It is not our desire here to support any particular structure for the dinitrogen tetroxide molecule ; but our work on ionic reactions has shown that the molecule should be capable of dissociation into NO^+ and NO_3^- units, as a result of simple electron transfer processes. Ingold[5] considers that the results of Levy and Scaife[4] provide additional and conclusive proof of structure (I).


(I)


(II)

Ionic dissociation of this molecule (equation 1) would involve the breaking of the N–O bond and transfer of the oxygen atom, whereas ionization of molecule (II) postulated by Longuet-Higgins[6] would involve no atom transfer, while at the same time satisfying physical evidence regarding symmetry[7].

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R. Thompson

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May 1.

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[1] *J. Chem. Soc.*, 1356 (1901).
[2] Angus and Leckie, *Trans. Farad. Soc.*, **31**, 958 (1935).
[3] Klinkenberg, *Chem. Weekblad*, **35**, 197 (1938).
[4] *J. Chem. Soc.*, 1093 (1946).
[5] *Nature*, **159**, 743 (1947).
[6] *Nature*, **153**, 408 (1944).
[7] Sutherland, *Proc. Roy. Soc.*, A, **141**, 342 (1933).

A General Solution for the Force Constants of Polyatomic Molecules

It is well known that the fundamental vibration frequencies of polyatomic molecules can be predicted with an error of only 1 or 2 per cent by solving the secular equation with force constants obtained from related molecules[1]. The reverse process of solving for the constants in terms of the frequencies is, in general, impossible unless some special assumptions are made concerning the force field[2]. The following general solution is therefore of some interest.

The nth order secular equation can be written in matrix form as follows:

$$|dA-\lambda I| = 0. \tag{1}$$

The elements of d are the force constants d_{ij} in the general potential function:

$$2V = \sum_{i=1}^{n}\sum_{j=1}^{n} d_{ij}\Delta_i\Delta_j. \tag{2}$$

The Δ_i are valence-type co-ordinates, expressed in terms of N further co-ordinates z_j:

$$\Delta_i = \sum_{j=1}^{N} a_{ij}z_j, \tag{3}$$

all possessing any required symmetry properties, and the elements of A (related to the inverse kinetic energy matrix G used by Wilson[3]), are defined as follows:

$$A_{ij} = A_{ji} = \sum_{k=1}^{N} a_{ik}a_{jk}\frac{M}{m_k}, \tag{4}$$

m_k being the mass for the co-ordinate z_k and M some arbitrary mass, introduced in order that the A_{ij} shall be pure numbers. I is the unit matrix, and the quantity λ is defined as follows:

$$\lambda = 4\pi^2\nu^2c^2M, \tag{5}$$

ν being the frequency of vibration in cm.$^{-1}$ and c the velocity of light in cm. sec.$^{-1}$. The $(N-n)$ null vibrations factorize out, giving (1). If the subscripts are ordered so that Δ_i is the approximate normal co-ordinate for ν_i, corresponding to the vibrational assignment, and if $\nu_1 > \nu_2 \ldots > \nu_n$, then the proposed general solution for the constants is obtained by equating to zero all elements below the diagonal of the determinant (1), thus reducing it to the product of n linear factors, and substituting λ_1 to λ_n in order in the n diagonal elements; that is:

$$\left.\begin{aligned} &\sum_{i=1}^{n} A_{ki}d_{ki}-\lambda_k = 0, \ (k = 1,\ 2 \ldots n). \\ &\sum_{i=1}^{n} A_{qi}d_{pi} = 0, \ (p > q). \end{aligned}\right\} \tag{6}$$

The corresponding (unnormalized) normal co-ordinates are given by:

$$z_i^{\nu_k} = \sum_{j=1}^{k} a_{ji}\,\frac{M}{m_i}\,{}^{k}|A|_{kj} \tag{7}$$

$$\Delta_p^{\nu_k} = \sum_{j=1}^{k} A_{pj}\,{}^{k}|A|_{kj}, \ (= 0 \text{ for } p < k). \tag{8}$$

where ${}^{k}|A|_{kj}$ are first minors of the kth order determinant formed from the first k rows and columns of the matrix A. The normal co-ordinate for ν_i involves only the co-ordinates Δ_i to Δ_n; the method, in effect, factorizes out the frequencies in descending order, the molecule increasing in rigidity as factorization proceeds. If only the constants for the m lowest frequencies are required, only elements in the last m rows of (1) need be considered, without introducing any fresh approximation.

The above solution is found to give surprisingly good results with actual examples, and is easy to apply. For molecules in which all the fundamentals fall into the category of 'group vibrations', factorization of the secular equation will clearly give a close approximation; where $(\nu_i - \nu_{i+1})$ is small and Δ_i and Δ_{i+1} overlap, the approximation will not be so close, since the normal co-ordinate for ν_{i+1} would then certainly involve Δ_i; but only the constants d_{ii}, $d_{i(i+1)}$ and $d_{(i+1)\,(i+1)}$ will be much affected. The constants obtained in (6) are always real, and the normal co-ordinates defined in (7) and (8) correspond to the vibrations having idealized geometrical forms; thus, in valence vibrations the atomic displacement vectors lie directly along the appropriate valence bonds. Interactions which would normally be discarded are here generally found to be negligibly small; their retention gives the unambiguous solution.

The method can obviously be adapted to predict vibration frequencies, by substituting constants only in the diagonal elements of (1); the inconsistency in the force field can then be estimated by evaluating terms below the diagonal.

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May 6.

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[1] Crawford and Brinkley, *J. Chem. Phys.*, **9**, 69 (1941). See also Pitzer and others, *J. Res. Nat. Bur. Stand.*, **38**, 1, 191 (1947).
[2] Glockler and Tung, *J. Chem. Phys.*, **13**, 388 (1945).
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Study of the Action of Ultra-violet Light on Urease by Means of the Ultracentrifuge

The action of ultra-violet light on serum albumin has been studied with the ultracentrifuge by Svedberg and Brohult[1] and by Sanigar, Krejci, and Kraemer[2]. Irradiation of serum albumin at room temperature and at 0° C. causes the formation of low-molecular substances and a general inhomogenization of the protein.

It seemed worth while to perform a similar experiment with a protein having enzymatic activity in order to see if inhomogenization accompanies loss of activity, or is a process resulting from the absorption of quanta beyond those required on the average for inactivation. For irradiation, monochromatic light of 2537 A. was used, at which a quantum yield of inactivation of 0·000926 has been found[3]. Inactivation involves a 'one-hit' process, that is, only one quantum is required for inactivation, although many (1,100) quanta may be absorbed on the average without producing inactivation.

A solution (0·5 per cent) of crystallized urease, *p*H 7 in 0·02 *M* phosphate buffer, was sedimented at 60,000 times gravity. It gave a sedimentation constant, S_{20}, of 18·2 Svedberg units, with a heavier component, S_{20} equal to 27·5, present to the extent of about 20 per cent of the total protein. This compares within the experimental error with earlier results of Sumner *et al.*[4], who found S_{20} equal to 18·6 for the main component in their best preparation. After a loss in activity of 45 per cent by irradiation, a main component with S_{20} equalling 15·0 was present to the extent of 60 per cent of the main component of the control sample. Comparison showed an increase in the amount of material both lighter and heavier than the main component. In a second experiment the activity of one aliquot was reduced to 66 per cent by radiation, and of another aliquot to 63 per cent by heating in a water bath at 80°. After irradiation, a fairly sharp main component remained. Following heat denaturation, however, no clearly defined component was visible, the material having become extremely polydisperse and inhomogeneous.

These results show that the decrease in activity of the irradiated solutions was about equal to the decrease in concentration of the main component, and the average molecular weight of this component was somewhat decreased. This, together with the appearance of more heavy material, suggests that irradiation brings about a primary process of inactivation and depolymerization followed by aggregation of the depolymerized material. Adjustment of irradiated solutions to the isoelectric point is known to augment this second step by inducing precipitation[2]. That ultra-violet light is more specific in its action than is heat is also indicated. The latter agent produces a more general distribution of particle sizes resulting, doubtless, from a spectrum of energy which breaks bonds at random. Monochromatic light, however, which is selectively absorbed at aromatic residues[5], would tend to produce more well-defined fragments by breakage of bonds next to chromophores.

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May 3.

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[2] Sanigar, E. B., Krejci, L. E., and Kraemer, E. O., *Biochem. J.*, **33**, 1 (1939).

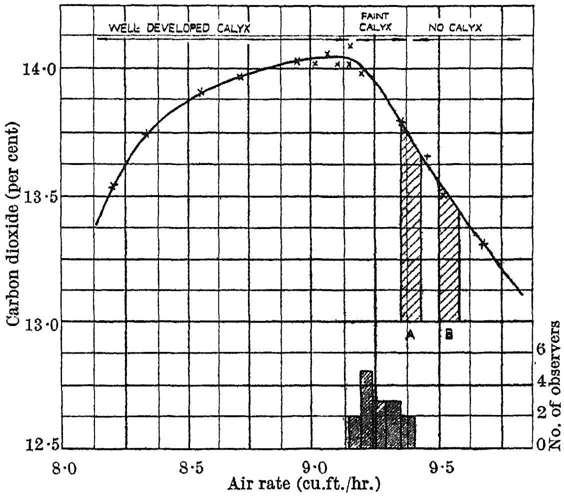
[3] Landen, E. W., *J. Amer. Chem. Soc.*, **62**, 2465 (1940).

[4] Sumner, J. B., Gralen, N., and Eriksson-Quensel, I., *J. Biol. Chem.*, 125–37 (1938).

[5] Mitchell, J. S., and Rideal, E. K., *Proc. Roy. Soc.*, A, **167**, 342 (1938).

Use of the Calyx Burner to Determine Combustion Conditions

H. Rostron Hindley[1] has recently directed attention to the limitations of the calyx flame as an indicator of maximum carbon dioxide concentration in products of combustion. His letter seemed to us inconclusive, as the scale of air flow in the accompanying diagram was arbitrary and hence gave no indication of the magnitude of the possible error in terms of air/gas ratio. There was also no indication of the relation between the peak concentration of carbon dioxide and the theoretical mixture. It cannot be assumed that these two points would coincide under the combustion conditions prevailing in the calyx burner. As we had not previously considered the calyx flame as an indicator of maximum concentration of carbon dioxide, it was thought to be worth while making further tests with this application in mind.



Gas rate, 2·49 cu.ft./hr. throughout.
A, total air requirement calculated from analysis
B, ,, ,, ,, ,, using Wood's formula (lines indicate limits of probable error)

Using a calyx burner of the type described by Brinsley and Stephens, determinations of the total air requirement of Birmingham towns gas were made by three observers having considerable experience of calyx observation, one of whom was known from previous special tests to have sensitive colour vision. Comparison was made with twelve other observers used to scientific observations but having no special training in, or experience of, calyx observation. One of these observers was also known to have specially sensitive colour vision. At the same time a series of carbon dioxide determinations were made, and the total air requirements of the gas were calculated both directly from the gas analysis data and also using J. W. Wood's formula[2]. As an additional confirmation of the value of the maximum carbon dioxide concentration an analysis was made of the products of combustion from a Boys calorimeter and the carbon dioxide calculated on an oxygen-free basis. This confirmed the peak concentration shown on the full line in the accompanying diagram.

The point of disappearance of the calyx as determined by the two colour-sensitive observers fell consistently on the left-hand limit of the region marked 'no calyx'. The end points in the case of all the other observers except one fell between the right-hand end of the range marked 'well developed calyx' and the 'no calyx' limit. One observer had difficulty in seeing the calyx under any conditions. The frequency distribution of observations adjusted to a constant number of observations per observer is also shown on the diagram. Although the number of observers is insufficient to obtain a statistically valid distribution, this information is included for the sake of completeness. The extreme range of error in the determination of air/gas ratio was about ± 1·5 per cent, which is sufficiently accurate for most purposes connected with gas appliance design and with observations of gas quality.

It will be seen from the diagram that the end points of the two colour-sensitive observers agreed well with the values for the total air requirement calculated from the gas analysis data. The latter were definitely not coincident with the peak of the carbon dioxide curve.

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[1] *Nature*, **161**, 395 (1948).

[2] *Nature*, **157**, 622 (1946).

A New Method for the Preparation of Adsorbents for Chromatography

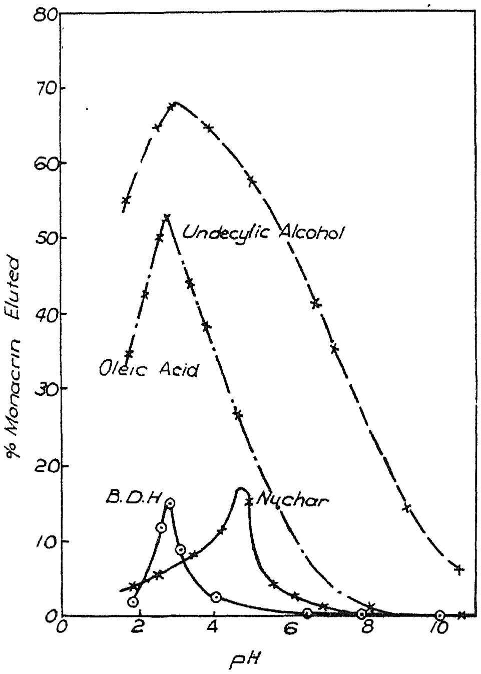
THE technique of chromatography, as used at present, is limited to a few adsorbents and usually to non-aqueous systems, due to the difficulty of elution of the adsorbate. However, aqueous systems could be used if adsorbents were available which permitted adsorption and desorption to be controlled by *p*H adjustment. This procedure is possible in some cases with synthetic ion exchange resins which have been used to a limited extent for the separation of mixtures of inorganic ions, organic bases such as thiamine, and some amino-acids. However, organic bases cannot always be recovered quantitatively even by elution with strong acids. 'Sodium cotton succinate' has been used for the quantitative adsorption and recovery of histamine, which could not be eluted quantitatively from ion exchange resins[1].

Activated charcoal has not generally been used for chromatographic separation of water-soluble substances because of its high adsorptive power and the subsequent difficulty of elution. It has been used for three-stage countercurrent adsorption of certain antibiotics such as penicillin, where an organic solvent is used for elution, followed by an additional extraction into buffered solution.

By adsorption of a surface-active or water-insoluble acid, for example, fatty acids or lecithin, as a 'primary' adsorbate, on adsorbents such as alumina, activated charcoal, or even carbon black, I have prepared a simple and versatile adsorbent similar in behaviour to an ion exchange resin. The adsorbent acquires the properties of the 'primary' adsorbate, and forms, under alkaline conditions, salts with cations or bases which may be considered as a 'secondary' adsorbate. The 'secondary' adsorbate can be eluted by acid solution. This eliminates the use of organic solvents and permits the immediate re-use of the prepared adsorbent.

Cationic surface-active agents, or insoluble bases, may be used in place of the fatty acids as a 'primary' adsorbate to prepare adsorbents for acids or anions. Similarly, the 'primary' adsorbate may be any substance that can form a complex with the materials to be separated or fractionated; for example, the lignin protein reaction might be utilized for the fractionation of some protein mixtures.

Typical curves for the adsorption of 'Monacrin' (5-amino acridine) directly on 'Nuchar' and B.D.H. decolorizing charcoal (reproduced herewith) are in agreement with the findings of Hauge[2], Olin[3] and Sastri[4], who showed that the adsorption of electropositive substances on activated charcoals is a minimum in the region of a characteristic *p*H termed the isoelectric point.



0·05 gm. adsorbent: 10 ml. 4×10^{-3} *m/L* 'Monacrin'

A similar curve is also shown for the adsorption of 'Monacrin' on B.D.H. charcoal pretreated with 20 per cent of its weight of oleic acid. Two distinct adsorption processes occurred. The curves indicate that above a *p*H value of approximately 6, the 'Monacrin' reacted with oleic acid to precipitate an insoluble salt on the adsorbent. In this *p*H range the salt formation was the principal adsorption mechanism, and strong adsorption was observed for both strong and weak adsorbents, such as B.D.H. charcoal and acetylene black. Below this *p*H-range, free base was liberated from the salt and was apparently adsorbed on the oleic acid layer, the degree of adsorption depending on the adsorptive power of the carbon. Thus B.D.H. charcoal showed a minimum adsorption amounting to 50 per cent of the 'Monacrin' at *p*H 3·0, whereas acetylene black similarly treated with oleic acid showed practically complete elution. Increasing the amount of adsorbed oleic acid in the pretreatment reduced the 'Monacrin' adsorption.

By selecting a carbon with a suitable isoelectric point, and an acid or base of the required strength, a great variety of exchange adsorbents can be prepared. For single-stage adsorptions, quantitative adsorption and elution of the adsorbate are desirable, and may be achieved by using a weak adsorbent such as acetylene black coated with oleic acid. Chromatographic separations require a stronger adsorbent to permit development.

The adsorption is also shown in the accompanying graph, under the same conditions, of 'Monacrin' on B.D.H. charcoal pretreated with 40 per cent of its weight of undecylic alcohol as 'primary' adsorbate. In this case salt formation cannot occur, and the 'Monacrin' is bound by adsorptive forces only, which appear to be electrostatic in nature[5]. Thus any factor which varies the dielectric constant of the 'primary' adsorbate film, and hence the surface charge, might be expected to alter the degree of adsorption. In this manner, a great variety of adsorbents may be prepared.

This work will be discussed in detail in a paper to be published elsewhere.

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[1] McIntire, Roth and Shaw, *J. Biol. Chem.*, **170**, 537 (1947).

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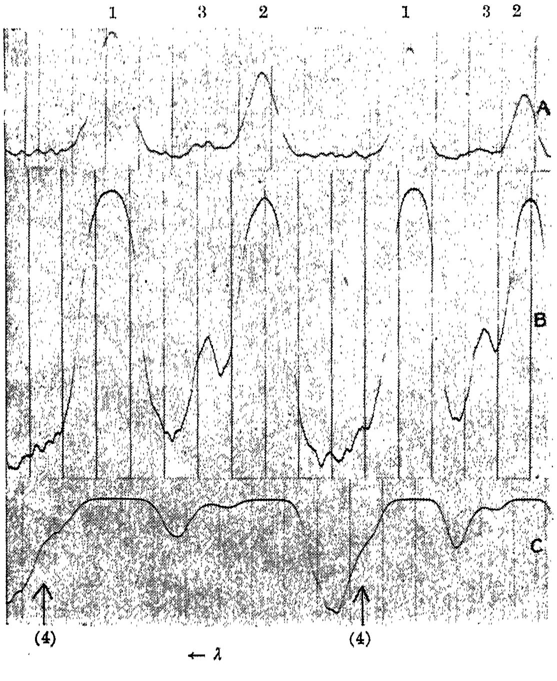
Fine Structure of the Hydrogen α-Line

Though the doublet structure of the Balmer lines has been known for sixty years, attempts at a more complete resolution of the fine structure have met with difficulties owing to the large Doppler width of the individual lines. In the α-line, a third component arising from the transitions $2S_{1/2}$–$3P_{1/2}$ and $2P_{1/2}$–$3S_{1/2}$ was resolved by Williams[1] in 1938, using a deuterium discharge tube in liquid air; but the resolution was not complete enough to allow an accurate measurement of the positions of the components. From these results, Pasternack[2] deduced a displacement of about 0·03 cm.$^{-1}$ of the $2S_{1/2}$ level from its position given by Dirac's theory. This value was no more than a rough estimate, and only through the microwave experiments of Lamb and Retherford[3] was the reality of the shift established.

By using a deuterium discharge tube immersed in liquid hydrogen and run at very low current densities ranging from 2 to 6 milliamp. per sq. cm., we have been able to resolve the third component much more completely, and under conditions where the relative intensities are in qualitative agreement with the theoretical prediction for undisturbed atoms. Fabry-Pérot étalons with spacings of 5 mm. and 7·5 mm. were used.



The photometer tracing *A* shows the main components (1) and (2), the latter appreciably weaker as predicted by the theory. Tracing *B*, of a plate with longer exposure, shows the component (3) well resolved from (2). As the result of measurement of thirty-six fringes in eleven different exposures, the spacing (3)–(1) was found to be 0·183 ± 0·005 cm.$^{-1}$.

Though each of the three components is a blend of two unresolved lines, in both (1) and (3) one of the two constituent lines is so weak that its presence has only a small influence, a rough estimate of which is sufficient. With these corrections, our results lead to an upward displacement of the $2S_{1/2}$ level of 0·043 ± 0·006 cm.$^{-1}$.

This value does not agree well with the shift of 0·033 cm.$^{-1}$ found by Lamb and Retherford. These authors do not apparently claim great accuracy for their measurements; but an error of more than 10 per cent would have to be assumed to make them compatible with our results. The values of the radiation shift of the $2S_{1/2}$ level calculated by Bethe[4] and Dyson[5] are 0·033 and 0·034 cm.$^{-1}$, which agree with Lamb and Retherford's measurements, but not so well with ours.

With very long exposures, we have also been able to resolve and to measure a fourth component due to the transition $2P_{3/2}$–$3S_{1/2}$. On account of its small intensity, it had not hitherto been resolved from the fifty times stronger component (1). It can be seen in tracing *C*, in which the other lines appear broadened by over-exposure. The separation (1)–(4) was found to be 0·138 ± 0·006 cm.$^{-1}$.

The measurement of this new component allows the position of the term $3S_{1/2}$ to be determined. The value 0·138 of the separation (1)–(4) would give the position of the $3S_{1/2}$ term in almost complete agreement with Dirac's theory (only 0·003 cm.$^{-1}$ higher), whereas Bethe's theory predicts an upward shift of 0·011 cm.$^{-1}$. On account of the incomplete resolution, however, we do not claim that our value for this term is completely certain.

Further work is being done in an effort to achieve better resolution.

We are greatly indebted to Prof. F. Simon and his co-workers for the supply of liquid hydrogen.

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G. W. Series

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July 22.

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Photodisintegration of Deuterium and Beryllium by Thorium C″ γ-Rays

The ratio has been measured between the numbers of neutrons emitted from sources made by placing 300 mC. of radium–thorium in the centre of spheres of heavy water and beryllium respectively. These sources emit neutrons according to the well-known reactions:

$$\mathrm{H}_1^2\,(\gamma,n)\,\mathrm{H}_1^1 - 2\cdot18\ \mathrm{MeV}. \qquad (1)$$

and

$$\mathrm{Be}_4^9\,(\gamma,n)\,\mathrm{Be}_4^8 - 1\cdot63\ \mathrm{MeV}. \qquad (2)$$

$$[\mathrm{Be}_4^8 \rightarrow 2\mathrm{He}_2^4 + Q].$$

Since thorium C″ emits a γ-ray of 2·62 MeV. energy, this leads to neutron energies of 0·22 MeV. and 0·80 MeV. respectively.

The heavy water used was of 99·6 per cent purity and was contained in a lead glass sphere 5 cm. in diameter with a cylindrical space 9 mm. long and 7·5 mm. diameter at the centre to contain the radium–thorium capsule. The beryllium was a machined sphere of pure beryllium metal 11 cm. in diameter, with a central cylindrical space 7·5 mm. long and 6 mm. in diameter. The relative numbers of neutrons emitted from these sources have been measured by slowing them down in a large tank of water and integrating the slow neutron density set up in this tank by using manganese foil detectors, the β-activity of which is afterwards measured by means of a Geiger counter with a thin aluminium wall. This ratio is

$$N_{\mathrm{Be}}/N_{\mathrm{D}} = 1{\cdot}26 \pm 0{\cdot}03.$$

From this ratio, and the data above, the ratio between the photo-disintegration cross-sections for beryllium and deuterium for a γ-ray energy of 2·62 MeV. energy can be calculated, a correction being applied for absorption of γ-rays in the deuterium and beryllium, making use of the absorption coefficients given in the "Handbook of Physics and Chemistry". The ratio then becomes

$$\frac{\sigma(\gamma n)\mathrm{Be}}{\sigma(\gamma n)\mathrm{D}} = 0{\cdot}35 \pm 0{\cdot}01,$$

a value in good agreement with the recently published work of Russell, Sachs, Wattenberg and Fields[1], who found values for $\frac{\sigma(\gamma n)\mathrm{Be}}{\sigma(\gamma n)\mathrm{D}}$ of 0·30 at 2·50 MeV. γ energy, and 0·43 at 2·76 MeV. γ energy.

A second determination was made using a 'long counter'[2] instead of a water tank to compare the neutron output of the two sources. These measurements give a value

$$\frac{\sigma(\gamma n)\mathrm{Be}}{\sigma(\gamma n)\mathrm{D}} = 0{\cdot}36 \pm 0{\cdot}03,$$

in good agreement with the first method.

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[1] Russell, B., Sachs, D., Wattenberg, A., and Fields, R., *Phys. Rev.*, 73, 6 (1948).

[2] Hanson, A. O., and McKibben, J. L., *Phys. Rev.*, 72, 8 (1947).

Cold Working of Aluminium at Low Temperatures

At the suggestion of Prof. J. Reekie of the University of Toronto, I have carried out a few experiments on the cold working of aluminium at room and liquid air temperatures. These show that although the metal is spontaneously self-recovering during cold working at room temperatures, it shows lattice distortion effects if the plastic deformation is carried out at the temperature of liquid air and the specimen is maintained at that temperature. The aluminium used was 'H.S.' brand, supplied by Messrs. Johnson Matthey and Sons, Ltd. The X-ray back-reflexion method was chosen for investigation of lattice distortion.

An aluminium rod with quite small crystals was first cold-worked by striking with a centre punch at room temperature. X-ray back reflexion pictures taken before and after cold working showed that the radial breadth of the rings in the X-ray pattern did not increase. The aluminium was then brought to the temperature of liquid air, when a third photograph was taken. This showed no line broadening. With the specimen at the low temperature the aluminium was again cold-worked. The rings were now considerably broadened. On allowing the specimen to warm up to room temperature, it was found that the line broadening disappeared and large spots on the rings indicated the process of recrystallization.

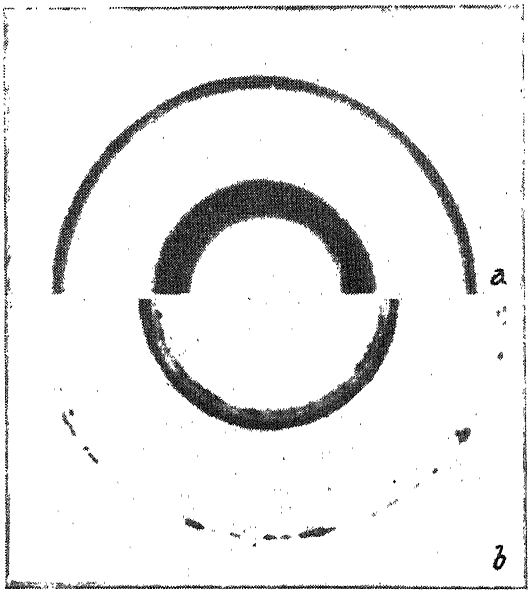

Fig. *a* shows the line broadening of the [420] and [331] rings on cold working at −180° C., while Fig. *b* shows the sharpening of the lines and the appearance of large crystals on allowing the specimen to warm up to room temperature. Cobalt *K* radiation was used in both cases.

The possible causes of general line broadening are: (1) variation of interplanar spacings in the metal due to variations in composition; (2) thermal fluctuations during the time of exposure; (3) small crystallite size; (4) variation of interplanar spacings due to mechanical strain. Causes (1) and (2) may be ignored because of the purity of the aluminium and the absence of line broadening with an unworked specimen photographed at −180° C. It is impossible on the evidence available to differentiate with any certainty between (3) and (4). The line broadening due to the fine-grain effect is given by the Scherrer formula $\Delta B = 0{\cdot}9\lambda/t \cos\theta$, where λ is the wave-length used, *t* the linear particle size and θ the Bragg reflexion angle. In the present experiment this would give an increase of just less than 1 mm. in the [420] ring with cobalt *K* radiation if the crystallite size decreased from about 10^{-4} cm., when the rings become continuous, to 10^{-5} cm. Now Wood[1] concludes that the lower limit of crystallite size produced in aluminium by very severe cold working is about 10^{-4} cm. On such a view the present line broadening of more than a millimetre would appear to be mostly due to mechanical strain.

There was no evidence in the present short series of experiments of the impossibility of producing complete rings after cold working, which was also noted in Wood's paper. Further work on this latter point will have to be done before a definite conclusion can be given.

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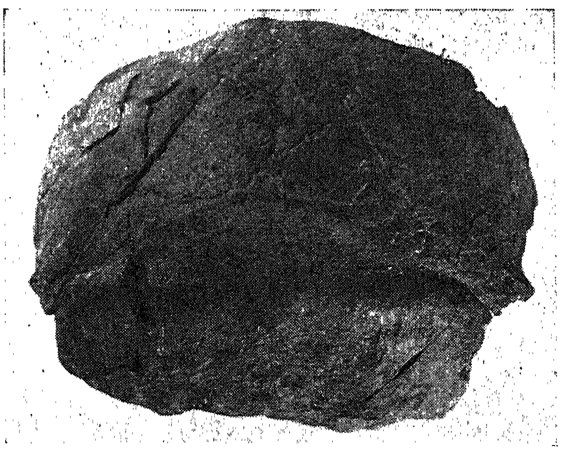
[1] Wood, W. A., *Proc. Roy. Soc.*, A, 172, 231 (1939).

A (?) Promethean *Australopithecus* from Makapansgat Valley

DURING 1947 the Bernard Price Foundation for Palæontological Research in the University of the Witwatersrand maintained an archæological party in the Makapansgat Valley, twelve miles north-east of Potgietersrust. Their principal objective was to excavate the Cave of Hearths, a site of human habitation containing palæoliths of Chell-Acheul facies embedded in limestone breccia.

About a mile lower down the same valley is the Limeworks site where no implements have been found and from the dumps of which students and members of the staff of the Anatomy Department have been recovering primate and other mammalian fossils for several years past. The presence of *Parapapio broomi*, Jones, in the lowest stratum of the Limeworks cavern breccia shows that this earliest stratum belongs to the same geological horizon as that of Sterkfontein. Consequently it was a happy confirmation of our expectations when Mr. James Kitching came across an australopithecine occiput in this type of breccia during September 1947, while searching among the Limeworks dumps.

The new occiput (see photograph) exhibits an *Australopithecus* comparable in brain size to *Paranthropus robustus*, Broom, from Kromdraai. Owing to partial synostosis of the sagittal and lambdoid sutures the cranial fragment comprises the major portion of the occipital bone including most of the right margin of the foramen magnum and the posterior third of each parietal bone. It displays several significant humanoid anatomical features, namely, an expanded planum occipitale ; an inferior situation of the inion relative to the opisthocranion and a consequent downward deflexion of the planum nuchale (thus proving the upright posture) ; the existence, but moderate development, of a torus transversus occipitalis (thus indicating the lack of a gorilloid 'bullneck' in the type) and the presence of a sutura transversa occipitalis (or sutura mendosa) with subsidiary sulci forming a complex 'Inca' bone (which has never been found hitherto in anthropoids).



Australopithecine occiput from the Makapansgat Valley

In all these features the Makapansgat *Australopithecus* distinguishes itself from its smaller-brained contemporary *Plesianthropus* at Sterkfontein. Further, if *Paranthropus* is geologically more recent (as Broom believes), the Makapansgat type probably differed considerably from *Paranthropus*. The final answer to this question must await the discovery of further remains.

But the most potent reason for separating the new fossil from its relatives is the difference between the bone breccia of Makapansgat Limeworks on one hand and the bone breccias of all the other manape sites on the other. The breccia shows first that the Makapansgat *Australopithecus* had advanced hunting habits and secondly that it was acquainted with the use of fire. Both of these inferences from the breccia were announced nine months before the discovery of the occiput in a communication to the First Pan-African Congress of Prehistory at Nairobi in January, 1947. They are briefly recapitulated here to explain why the name, *Australopithecus prometheus*, has been given to this specimen.

In addition to the Sterkfontein types of baboons such as *Parapapio broomi*, Jones, and *Parapapio jonesi*, Broom, the Makapansgat breccia has yielded fourteen species of Bovidæ, eight of which appear to be new ; three carnivores (namely, lion, hyena and jackal) ; two extinct pigs ; a rhinoceros ; a hippopotamus ; and two giraffes (including the extinct *Griquatherium*). Thus apart from the elephant we have concrete evidence that these creatures drew upon every family of big game found in Southern Africa for their food supply. The dentitions of the big game specimens, however, show that these Australopithecines were more frequently successful in slaying juvenile and aged representatives of these various mammalian families. But the profusion of the bone breccia shows that they were capable and successful in their hunting of very big game.

In 1925 the presence of *Australopithecus* was unsuspected because of the great size of these bones and their charred appearance—so the specimens of this Makapansgat Valley Limeworks bone breccia were submitted to two chemists (Drs. Moir and Fox) for analysis to discover whether the bones had been subjected to fire. From the great size of the beasts represented in the breccia, the intentional fracturing or splitting of the bones, and corroborative reports of the chemists relative to the presence of carbon, the deposit was claimed at that time as a primitive human kitchen midden. To-day it appears that all this 'human' activity at Makapansgat Limeworks site is the handiwork of man's australopithecine predecessors. No traces of stone implements have been found in the Makapansgat Limeworks strata nor have they been found at Taungs, Sterkfontein and Kromdraai. But we have found at Makapansgat a number of large ungulate humeri the epicondylar ridges of which were battered and broken and apparently as the result of deliberate use prior to their fossilization. Most of the bones are fresh and firm, and display clean clear lines of gross fracture before fossilization, but others crack and crumble easily. These exhibit so fine a state of macroscopic and microscopic cracking as to preclude explaining their pre-fossilization fragmentation by the crude impact of stone or bone. The most likely force to have been responsible for their crumbling and altered condition is heat. That fire was the splintering agent is corroborated by their discoloration, disintegration and the chemical reports of free carbon made more than twenty years ago, and by the vesicular character of the adjacent glassy collophanites and clays recently discovered in the breccia by Dr. V. L. Bosazza and the comparative analysis he has made of ashy deposit from the breccia with ash from local Transvaal wood.

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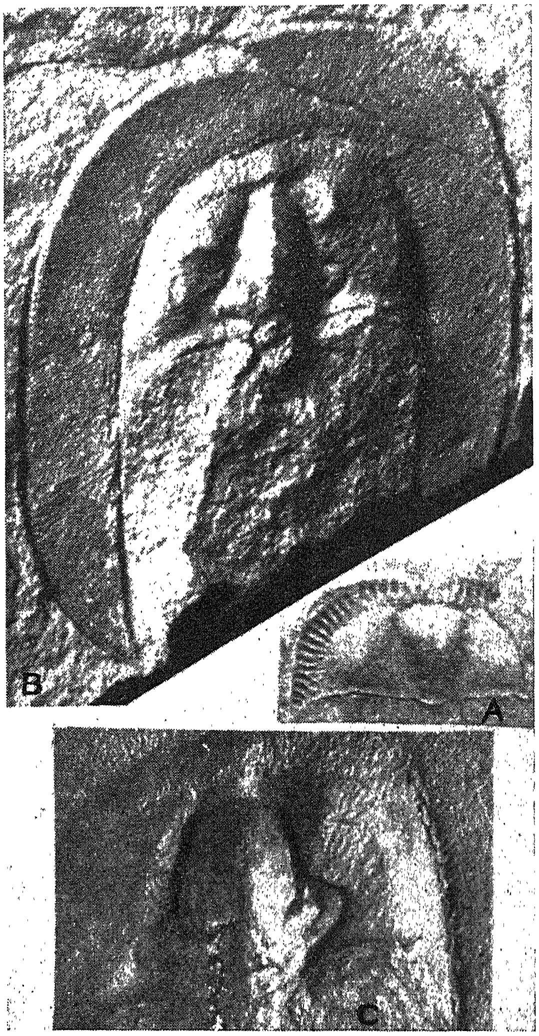
Indications of Cephalic Sutures in Trinucleidæ and Harpedidæ

RUDOLF RUEDEMANN[1] in 1916 summarized the available evidence regarding traces of cephalic sutures in Trinucleidæ, Raphiophoridæ, Dionididæ, and Harpedidæ. The well-known marginal sutures in the first and last families he considered as secondary acquisitions. They are generally regarded as having facilitated ecdysis; but specimens are rarely found which have fractured along them. One might even draw a comparison between the marginal suture, which is nearer the dorsal than the marginal side of the brim, and the subcranial furrow of *Phacops* (*s.s.*). Ruedemann's reconstruction, especially of the anterior facial suture, from traces on internal moulds, is so interesting in the case of *Cryptolithus tesselatus* Green, in spite of P. E. Raymond's treatment[2] of the lateral eye-lines as genal cæca and not lateral parts of a facial suture, that for a number of years a look-out has been kept for corresponding evidence on the eastern side of the Atlantic.

In the case of *Cryptolithus* the search has not been rewarded; but in a number of internal moulds of *Trinucleus fimbriatus* Murchison, symmetrical breaks have been observed. For the most part only the remains of lateral (or posterior) facial sutures can be traced[3], but in a specimen recently obtained from Llan Fawr Quarry, near Llandrindod Wells, a semicircular anterior facial suture appears to be present and to run just outside the anterior pits and forward into the fringe so as to enclose a number of pits of the innermost concentric row. This is different from what happens in *C. tesselatus*, in which Ruedemann makes the anterior facial suture pass inside the anterior pits and not cross into the pitted part of the fringe.

It is important, as shown in Fig. *A*, that the posterior parts of the suture are continuous with the anterior suture in *T. fimbriatus*. In *C. tesselatus* the genal cæca (Raymond) or lateral sutures (Ruedemann) do not join the frontal facial suture. So far as traces of facial sutures count, *Cryptolithus* seems to be further from the Opisthoparian ancestor than *Trinucleus*, and it may be suggested that in species which ploughed through mud the tendency was for the anterior suture to migrate away from and not towards the periphery of the fringe or brim.



A. Trinucleus fimbriatus Murchison, Llan Fawr Quarry (*Nemagraptus gracilis* Zone), north of Llandrindod Wells, × 2. *B. Scotoharpes domina* gen. et. sp. nov., *Plectodonta* aff. *canastonensis* Siltstones, North Esk, Pentland Hills, × 3 (approx.). *C.* Part of the specimen shown in *B*, × 4

Good observations of posterior facial sutures have been made in *Scotoharpes domina* gen. et sp. nov., from fine Upper Gala silts of the Pentland Hills. On an external impression of the cephalon, a possible longitudinal suture was seen crossing the posterior border close to the glabella and running forward near the proximal side of an ala, where it was joined at right angles by a lateral suture bisecting the ala. This is even clearer on the internal mould (Fig. *B*, right side). Further examination suggests that the longitudinal suture cuts across the anterior extremity of the ala (Fig. *C*, right side). Perhaps its continuation is indicated by a scar which diverges outwards on the cheek towards the distal end of the genal cæcum. Possible traces of an anterior suture cannot be treated with certainty; but in Fig. *C* (left side) a fine ridge, indicating a furrow on the inside of the original cephalic shield, runs forward and then curves inwards towards the position of the first lateral furrow on the glabella. Attention may also be directed to the slight transverse angularity just in front of the glabella and even to the anterior furrow itself which separates inner and outer parts of the cheeks. Laterally this furrow is shallow, and on the left side where it approaches the distal end of the genal cæcum (Fig. *B*) a curvilinear raised ridge originates which runs back and then bends inward slightly to meet the posterior border. Can this conceivably mark the position of an early lateral or posterior suture at a stage when *Scotoharpes*, at least ancestrally, showed affinities with a genus like *Aulacopleura*? The possibility of such a relationship is supported by the recent work of Přibyl[4], in the general background of that by Stubblefield[5]. The definite suture close to the sides of the glabella suggests the condition in Olenidæ and Prœtidæ. *Prœtus loredensis* Delgado, in particular, has recently been compared with the Harpedidæ[6].

Ruedemann has suggested that the evolution of a genus like *Cryptolithus* has been marked by great lateral development of the cheeks. It is to this he attributes the length and parallelism of what he calls the "lateral facial sutures". While this may be true, one must also consider the likelihood of eyes migrating inwards and upwards on to the highest parts of the cheeks in a mud-dweller. Even if functional eyes were afterwards lost, the tendency for the migration towards the glabella appears to be supported by the course of the sutural traces in *Trinucleus fimbriatus*. Migration of eyes inward, possibly from the position of slight depressions behind the outer ends of the genal cæca in *Scotoharpes domina*, also may be arguable.

It is not easy to answer the question as to why traces of what may be facial sutures should remain on the inside of a cephalon of *Trinucleus fimbriatus*, unless they continued to serve as lines of easy splitting. In *Scotoharpes* the lateral and posterior sutures were evidently functional, and their presence on the alæ may mean that the latter had a sensory function during ecdysis and perhaps at other times.

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Changes in the Incisor Teeth and Incisal Alveolar Bone of Rats in Hypervitaminosis A and Avitaminosis A

THE changes in bone in avitaminosis A have been reported by Mellanby[1], Wolbach and Bessey[2], and Wolbach[3], who consider that the vitamin is concerned with the control of bone modelling. Mellanby found excessive formation of bone in certain areas during avitaminosis and that the osteoblasts and osteoclasts could reverse their positions at the effective bony surfaces. Wolbach[3] considered that appositional bone formation continued in the normal site, but that concurrent resorption of bone ceased. Excessive doses of vitamin A have been found by many writers to cause spontaneous fractures of bones and internal hæmorrhages (see Moore and Wang[4] for a review of the literature). Wolbach[3] considered that bone remodelling was greatly accelerated and that a defective tissue was laid down.

The effects of vitamin A deficiency on the teeth are already well known[5]. A defective dentin is laid down by the odontoblasts, especially on the labial side. Pohto[5] and Wolbach[3] both reported that hypervitaminosis A has no effect upon the rat's incisor teeth.

Through the kindness of Dr. T. Moore and Mrs. S. E. Walker, of the Dunn Nutritional Laboratory, Cambridge, I obtained the heads of animals suffering from hypervitaminosis A. These were young rats and had been given 40,000 I.U. of vitamin A daily for 10–42 days. Their incisal alveolar bone and upper incisor teeth were examined microscopically. In the alveolus, the rate of bone formation was greatly reduced, many cementing lines were seen and active osteoblasts were much less prominent than usual. Osteoclasts appeared to be unaffected, so that the bone became abnormally thin and disappeared in places. In the teeth, only dentin formation was affected. This became decreased in appositional rate, the interfibrillar cementing substance was gradually reduced in amount, and the lingual odontoblasts had begun to atrophy.

The avitaminotic material studied was from rats previously investigated (Irving and Richards[5,6]). The animals had been on the vitamin-free diet used by us 28–53 days from weaning. The alveolar bones showed considerable over-production of new bone. This occurred in areas where apposition was usually seen and also in situations where resorption normally occurred. In the early stages of the deficiency, the osteoclasts endeavoured to overcome the latter abnormal apposition, while working alongside invading osteoblasts. Later they became displaced by osteoblasts and some osteoclasts were found on the opposite side of the bone. On faces where excessive apposition occurred in the usual site for apposition, osteoclasts were never found. The changes in the teeth in avitaminosis were the same as those reported by earlier workers.

It is concluded from these results that the primary action of vitamin A is upon the osteoblasts. Excessive dosage with vitamin A depresses the action of these cells, and, when the vitamin is lacking from the diet, these cells engage in disorderly overactivity. The reactions of the osteoclasts in avitaminosis are purely secondary, in an attempt to prevent excessive bone formation. In hypervitaminosis A these cells continue to act as usual. The odontoblasts, cells in the teeth comparable to the osteoblasts, react in a way similar to that of the bone-forming cells, producing less dentin in hypervitaminosis and excessive amounts in avitaminosis.

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Marine Fish Cultivation

IN their recent review in *Nature*[1] of the papers on an experiment in marine fish cultivation by my colleagues and me[2], Cooper and Steven express the view, "that encouragement of fish growth in arms of the open sea such as the North Sea or the English Channel by the addition of plant nutrients can never be a paying concern". This categorical statement, based on a previous paper by Cooper[3], seems to bar once and for all any large-scale application of fertilizers to suitable parts of the sea. Leaving a fuller discussion to a forthcoming paper on fertilizer application in an open sea-loch, may I point out here that Cooper's arguments and figures do not, in my opinion, bear out his conclusion. For an assessment of the economics of fertilizing the sea we require figures showing: (*a*) the return in crop and stock per ton of fertilizer added to land, (*b*) the return in fish and shell-fish per ton of fertilizer added to the sea. The latter figures unfortunately do not exist. If our experiments have shown anything, it is the desirability of keeping an open mind to a rational approach to the whole problem of increasing the amount of human food growing in the sea, and pursuing research step by step along various lines, not excluding the fertilizing of suitable larger areas. As regards the threatening scarcity of phosphate, should it become necessary to recover it from the sea it may prove possible to extract it from water taken from greater depths of unproductive areas where the concentration of phosphate is high and its availability to plants low.

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WE do not agree that the expression of a view is a "categorical statement" barring any door to further research. Be that as it may, we still consider that no evidence has yet been produced in support of the belief that encouragement of fish-growth by artificial fertilization of arms of the open sea, such as the English Channel or North Sea, can be made a paying concern. On the other hand, there is no little evidence in support of the opposite view. Perhaps the most convincing is the failure of Dr. Gross and his colleagues to demonstrate that marine fish cultivation could be made to pay even in a very tiny and almost completely enclosed body of water.

A large-scale fertilization of the sea is continuously in progress, for our method in the most advanced countries of disposing of the sewage of coastal towns achieves just this. The discharge from Plymouth, which must be considerable, affects the nutrient content of Plymouth Sound but is soon dissipated in the open sea beyond the breakwater. Its effect on the English Channel has rarely been notable. The problem would be most easily studied in an area already nutrient-poor, such as the Mediterranean and its adjacent seas. Such studies by Bernard[1] off Monaco and off Banyuls near the Franco-Spanish frontier, and by Ercegović[2] and Nümann[3] in the shallow northern Adriatic, do not seem to have found any appreciable enrichment by sewage. A quantitative assessment of the effect of sewage from large coastal cities discharging into seas of low natural nutrient resources should provide the readiest means of testing Ritchie's thesis which Gross again propounds.

Though there is a continuing exchange of the waters of the English Channel or the North Sea with the Atlantic Ocean, it is not easy to place a measure on it; it would seem to be large. The work of Proudman[4] suggests that the Irish Sea empties itself through the North Channel and is replaced through the St. George's Channel in a very few years, perhaps no more than two. The phosphate to be added to such arms of the sea, to do any good, would need to be measured in thousands of tons per annum. That part not quickly harvested as fish would vanish into the ocean in a year or two. Though it seems true that four-fifths of the phosphate added to arable land becomes tightly bound in the soil complex, some of it is still available to plants such as lupins which can get it out again; and given time enough, may not a saturation value be reached beyond which phosphate added to the soil remains freely available to plants? Be the answer to this what it may, there is a difference between immobilizing riches in a safe deposit and broadcasting them throughout the five oceans.

As to the last sentence of Dr. Gross's letter, it is always dangerous to try to foretell scientific development. Though the phosphate and nitrate resources of the deep ocean are enormous, the concentration rarely exceeds 90 µgm./l. of phosphate-phosphorus, or 0·000003 *M*. In the near future, no engine devised by man is likely to harness this reserve better than the vast oceanic circulation and upwelling impelled by winds on a global scale, followed by production of plants and animals. Fisheries in the most favoured regions provide the best means yet known or foreseen of exploiting this natural asset. Our heritage of bird guano and rock phosphate, upon which we are so dependent, represents the final stages of this process of enrichment of surface ocean water by upwelling of deep water. This heritage is being replaced more slowly than it is being spent; we ought not to hasten the wastage.

We do not wish to bar any development once and for all. Economic justification of marine research can come only from the application of our increasing knowledge to problems of production from the sea. None the less, fervid advocacy of a very costly programme, followed by practical failure, could only bring the science of the sea into ill repute. Surely the right approach is through small-scale experiments to larger ones, establishing firm experience as we go. The Loch Craiglin experiment on these lines was thoroughly sound and worthy of critical appreciation. This we attempted in our review.

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ARCTIC AEROBIOLOGY, II

PRELIMINARY REPORT ON FUNGI AND BACTERIA ISOLATED FROM THE AIR IN 1947

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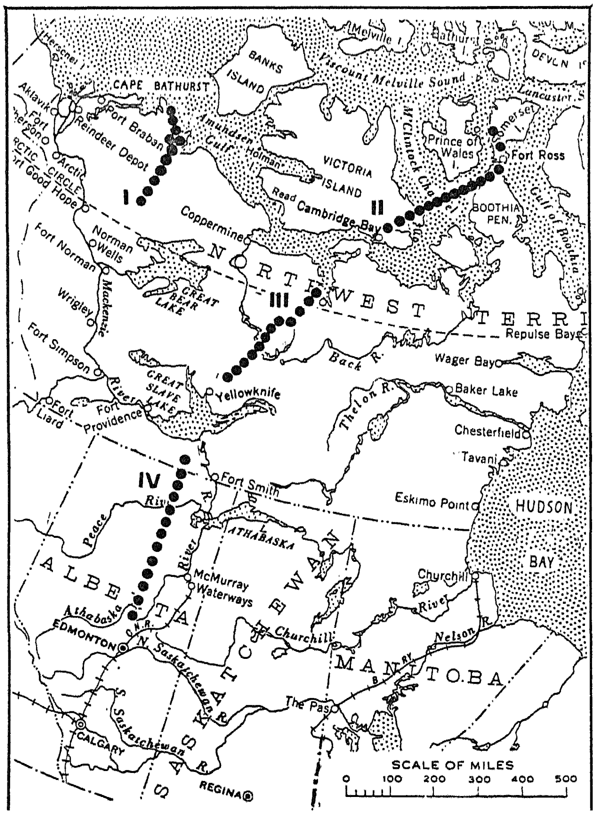
ALTHOUGH many studies have been made of the microflora of the air over temperate regions, little such work has been done in the Arctic. Meier and Lindbergh[1] made some preliminary studies by exposing petrolatum-coated slides at various points during Lindbergh's northern flight in 1933, six of these exposures being north of the Arctic Circle over Greenland. Owing to the death of Dr. Meier, only a brief report was published[2]. The following account presents the results of a series of exposures of nutrient plates in arctic and subarctic Canada in 1947, and also preliminary studies of the subcultures of bacteria and fungi obtained from these plates. The exposures were made by Prof. Polunin with the facilities provided by the Royal Canadian Air Force, of which a general account has recently been published[3]. 'Vaselined' slides were exposed at the same time for rust spores, pollen grains, etc., and the results of this examination will be published separately.



The medium employed was designed to allow minimal growth, since it was expected that a considerable time would elapse between exposure and arrival at the laboratory. Czapek's solution agar was accordingly modified by omitting the sucrose and adding yeast extract. On June 23 the first set of plates (standard 10 cm. Petri dishes) was prepared, using 0·4 per cent yeast extract; these plates were exposed on August 12. As it was found that micro-organisms made good growth on this medium, it was deemed advisable to modify further the formula; accordingly the yeast extract was reduced to 0·1 per cent, and the agar content increased to 2·5 per cent. This second lot of medium was prepared on July 14 and was used in the remaining flights. In both cases the poured plates were left for one week at room temperatures and any that showed contamination were discarded. Details of the wrapping of the plates and the technique of exposure have already been described[3].

Following exposure, each plate was carefully rewrapped and packed, the complete stock of exposed and unexposed plates being kept together until the work was completed in early September. When the plates were returned to the laboratory on September 12 and 13 they were in excellent condition, all showing numerous small colonies of micro-organisms. Seven unexposed plates were carried throughout, and these were sterile when returned to the laboratory and remained so even after one month at room temperature.

The relatively slow air-speeds (see Table 1) made exposure by hand feasible, and the plates were held at a minimum of 20 cm. from the fuselage. Flight I was made in a Norseman aircraft which has a single propellor situated in front of the nose, so that these plates (1 to 11) may have been affected by the turbulence caused by the propellor. Flights II to IV were made in a twin-engined Canso flying boat in which the propellors are behind the co-pilot's seat from which the exposures were made; this permitted an unobstructed air stream to strike the plates (12 to 52).

The attempt was made to obtain exposures every 20 or 30 miles in a series of flights that would extend from temperate regions as far north as possible. Of the four flights (see accompanying map), one was near the extreme north-west of Canada and reached as far as the Arctic Ocean, while the remainder extended from Somerset Island to Edmonton, Alberta.

No attempt was made to obtain cultures from all of the colonies in any one plate, only those in which the colonies were well isolated and uncontaminated being used. Despite this precaution, many of the cultures proved to be contaminated, due possibly to several micro-organisms being present on a dust particle. In some cases, examination with a dissecting microscope revealed numerous microscopic bacterial colonies within the mycelium, and these colonies were readily transferred along with portions of the fungous hyphæ. It was believed that these tiny bacterial colonies (which were not included in the counts) either found the medium to be unfavourable or were inhibited by the fungi. Similarly, minute fungous colonies were also noted, although much less frequently: two such colonies when transferred to corn meal agar failed to grow.

The numbers of colonies of bacteria and fungi are given in Table 1 along with relevant data. It is evident that bacteria greatly outnumber fungi in most of the fifty-one plates exposed.

Table 1. Results of two-minute exposures of nutrient plates

Plate No.	Hour	Airspeed m.p.h.	Lat. N.	Long. W.	Alt. (ft.)	No. of colonies Bacterial Per plate	Bacterial Per cu. ft.[1]	Fungal Per plate	Fungal Per cu. ft.[1]
Flight I, from Canso Lake to Cape Bathurst (Plates 1–11), August 12.									
1 *B*	18·24	90	67° 38′	127° 8′	3200	60	0·059	8	0·0079
2 *B*	18·34	105	67° 58′	126° 53′	5100	23	0·019	7	0·0059
3 *B*	18·44	110	68° 12′	126° 28′	5100	46	0·02	7	0·0057
4 *B*	18·54	112	68° 32′	126° 05′	5100	38	0·026	4*	0·0027
5 *B*	19·04	115	68° 54′	126° 02′	5100	16	0·0093	2*	0·0012
6 *B*	19·14	110	69° 06′	125° 43′	5150	32	0·026	0	—
7 *B*	19·24	110	69° 24′	125° 30′	5350	32	0·026	1	0·0008
8 *B*	20·26	90	Circling over pt.		4000	24	0·024	4	0·0039
9 *B*	20·35	100	69° 28′	125° 48′	5100	33	0·029	11	0·0098
10 *B*	20·45	110	69° 51′	126° 34′	5100	19	0·015	4	0·0032
11 *B*	20·55	115	70° 02′	126° 54′	1500	14	0·008	15	0·0087
Flight II, from Cambridge Bay to Somerset Island (Plates 13–27), August 26.									
13 *B*	5·17	113	69° 32′	103° 33′	3500	530	0·454	12	0·01
14 *B*	5·27	109	69° 45′	102° 55′	3000	400	0·324	14	0·011
15 *B*	5·37	115	69° 57′	102° 15′	4200	290	0·224	9	0·0069
16 *B*	5·47	115	70° 09′	101° 32′	4300	180	0·139	8	0·0064
17 *B*	5·57	116	70° 20′	100° 55′	4400	95	0·07	7	0·0051
18 *B*	6·07	115	70° 33′	100° 06′	4200	38	0·029	5	0·0039
19 *B*	6·17	115	70° 44′	99° 20′	4000	60	0·046	6	0·0047
20 *B*	6·27	116	70° 57′	98° 30′	4050	43	0·033	8	0·006
21 *B*	6·37	116	71° 08′	97° 40′	4200	45	0·034	3	0·0023
22 *B*	6·47	116	71° 20′	96° 50′	4100	95	0·075	6	0·0046
23 *B*	6·57	116	71° 31′	96° 00′	4100	112	0·083	6	0·0046
24 *B*	7·07	117	71° 43′	95° 10′	4000	74	0·056	8	0·0061
25 *B*	7·17	121	71° 54′	94° 05′	4000	89	0·064	102**	0·074
26 *B*	7·42	119	72° 34′	94° 25′	5000	47	0·044	3	0·0023
27 *B*	8·01	117	72° 38′	94° 28′	4500	79	0·08	12	0·009
Flight III, from Cambridge Bay to Yellowknife (Plates 28–39), August 27.									
28 *B*	9·38	109	66° 45′	108° 20′	4600	328	0·265	24	0·02
29 *B*	9·53	104	66° 27′	108° 47′	5500	185	0·158	10	0·0086
30 *B*	10·08	117	66° 05′	109° 18′	7300	124	0·092	15	0·013
31 *B*	10·23	109	65° 45′	109° 47′	6300	78	0·063	8	0·0065
32 *B*	10·38	109	65° 25′	110° 14′	6400	54	0·048	6	0·0049
33 *B*	10·53	115	65° 06′	110° 40′	6000	92	0·071	5	0·0039
34 *B*	11·08	115	64° 44′	111° 10′	5900	59	0·046	2	0·0015
35 *B*	11·23	115	64° 24′	111° 35′	5600	33	0·039	1	0·0008
36 *B*	11·38	115	64° 04′	111° 58′	5500	67	0·052	7	0·0054
37 *B*	11·53	115	63° 45′	112° 27′	5100	61	0·047	5	0·0039
38 *B*	12·08	115	63° 27′	112° 57′	5000	46	0·036	4	0·0031
39 *B*	12·23	117	63° 06′	113° 27′	4600	81	0·063	2	0·0015
Flight IV, from Yellowknife to Edmonton (Plates 40–52), September 5.									
40 *B*	8·38	115	60° 11′	114° 00′	5000	196	0·151	19	0·015
41 *B*	8·53	115	59° 46′	113° 58′	5000	71	0·055	33	0·025
42 *B*	9·08	115	59° 20′	113° 58′	5000	75	0·058	6	0·0046
43 *B*	9·23	115	58° 54′	113° 57′	5000	41	0·032	3	0·0023
44 *B*	9·38	117	58° 28′	113° 56′	5000	40	0·031	7	0·0054
45 B	9·53	117	58° 02′	113° 55′	5000	49	0·038	11	0·0085
46 *B*	10·09	119	57° 35′	113° 54′	5000	37	0·028	18	0·014
47 *B*	10·23	119	57° 11′	113° 53′	5000	21	0·016	11	0·0083
48 *B*	10·38	119	56° 46′	113° 52′	5000	80	0·06	32	0·024
49 *B*	10·53	119	56° 18′	113° 51′	5000	105	0·075	67	0·05
50 *B*	11·08	119	55° 52′	113° 50′	5000	147	0·11	79	0·052
51 *B*	11·23	119	55° 26′	113° 49′	5000	62	0·046	111	0·083
52 *B*	11·38	120	55° 00′	113° 48′	5000	476	0·35	306	0·23

* One contaminant observed immediately following exposure.

** Mostly secondary colonies from large central one of sporulating *Penicillium*.

[1] Figures computed from time of exposure, speed of aircraft, and area of plate: it should be emphasized that they represent comparative rather than precise quantitative values.

Table 2 summarizes the subcultures that were made from representative bacterial colonies, in forty-five of the fifty-one plates. Transfers were not made from the other six plates because of bacterial spreaders, or because the colonies were covered with mould. All the subcultures were made on to nutrient agar slopes.

Wolf[4], in studies of the air over Nashville, Tenn., and Proctor and Parker[5] over Boston, found spore-forming bacteria comprising a high percentage of their colonies (37·7 and 52·2 per cent, respectively) and a low percentage of Gram-positive non-spore-forming rods. In the present investigation about 5·0 per cent were spore-formers and about 41 per cent were Gram-positive non-spore-forming rods. On the other hand, the percentages of *Micrococcus* and *Sarcina* were very close to those found by Wolf[4].

Table 2. Summary of preliminary study of bacterial cultures

Micrococcus	43
Sarcina	5
Achromobacter (probably)	8
Achromobacter or *Flavobacterium*	24
Gram-positive rods (unclassified)	20
Gram-positive rods morphologically like *Corynebacterium*	46
Spore-formers	8
No growth on transfer	21
Mixed cultures	13
Total	188

Table 3. Summary of preliminary identification of fungous cultures

Fungi Imperfecti	*Hormodendrum*	33
	Other Moniliales	20
	Phyllosticta	1
	Pestallozia	1
Ascomycetes	Yeasts	16
	Penicillium	15
	Leptosphæria	9
	Chætomium	1
Actinomycetales	*Streptomyces*	22
Other cultures	Non-sporulating	74
	Sclerotia-producing	2
	No growth on transfer	9
	Contaminated	4
	Total	207

Table 3 is a summary resulting from an examination of the fungi. Subcultures were made on corn meal agar. The lack of sporulation in many of the cultures is probably due to the presence of bacterial contaminants, and possibly to an unfavourable medium.

These cultures will be purified and grown on various media in order to induce sporulation, and a detailed report including identifications will be published later. The almost universal prevalence of *Homodendrum* in the air as indicated by many workers, including Wolf[4], Proctor and Parker[5], Meier and Lindbergh[1], is confirmed by its occurrence in 33 of the 207 cultures (15 per cent). Conspicuously absent among the sporulating cultures were *Aspergillus, Fusarium* and Phycomycetes.

On the basis of the colonies which developed in our plates, it would appear that bacterial cells greatly outnumber fungus spores in the arctic air. There appears to be no correlation between the number of colonies and geographical position, at least within the arctic and subarctic regions. However, in the region of Edmonton an increase of both bacterial and fungous floras was found which may possibly be related to areas of cultivation.

No explanation can be given for the high numbers of bacterial colonies encountered in the vicinity of Cambridge Bay on two successive days. The highest count was found on August 26 on plate 13 exposed some 50 miles north-east of Cambridge Bay, and high numbers were also found in plates 14, 15, 16 exposed still farther north. High counts were again obtained the following day on plates 28 to 30, plate 28 being exposed some 170 miles south-west of Cambridge Bay.

[1] Meier, F. C., and Lindbergh, C. A., *Sci. Mon.*, **40**, 5 (1935).

[2] Meier, F. C., *Phytopath.* (Abs.), **25**, 27 (1935).

[3] Polunin, Nicholas, Pady, S. M., and Kelly, C. D., *Nature*, **160**, 876 (1947); *see* also *Arctic*, **1**, 60 (1948).

[4] Wolf, F. T., *Bull. Torr. Bot. Club*, **70**, 1 (1943).

[5] Proctor, B. E., and Parker, B. W., *J. Bact.*, **36**, 175 (1938).

FORMATION OF HYDROGEN PEROXIDE IN WATER IRRADIATED WITH X- AND ALPHA-RAYS

By Dr. P. BONET-MAURY and M. LEFORT
Laboratoire Curie, Institut du Radium, Paris

In spite of numerous studies, the primary action of ionizing radiations on water is not yet fully known. Knowledge of this action is important in relation to the radio-chemistry of dilute aqueous solutions and is required for the better understanding of the mechanism of the biological effect of these radiations, since water comprises about 80 per cent of living organisms. As the formation of hydrogen peroxide is regularly demonstrable in irradiated water[1], a systematic investigation of this phenomenon has been undertaken for radiations of very different ionic density, namely, 0·9 A. X-rays and polonium or radon α-rays.

Methods. The irradiation with X-rays and the titration of hydrogen peroxide were carried out by the methods already described[2]. In order to study the effect of dissolved oxygen, gases were eliminated from the water *in vacuo* by alternate evacuation and saturation with oxygen-free argon or nitrogen. Dissolved oxygen was titrated by a special method which permitted the assay of a 30-c.c. water sample, and the estimation of 0·2 mgm. of oxygen with an accuracy of 5 per cent. A control sample was assayed in an identical manner. Dissolved radon[3] or polonium was used as a source of α-radiation. Polonium was only employed under conditions which were such that the catalytic effect of this substance[4] on the decomposition of hydrogen peroxide was negligible.

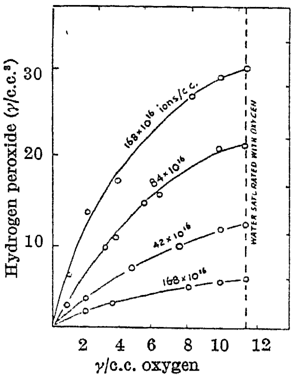


Fig. 1. Influence of dissolved oxygen. Doses of radiation: 168, 84, 42 and 16·8 × 10^{16} respectively

Effect of Dissolved Oxygen. (*a*) *X-rays.* For a given dose of radiation, the amount of hydrogen peroxide produced depends markedly upon the concentration of dissolved oxygen (Fig. 1). In water carefully freed from gas, it is no longer possible to detect any hydrogen peroxide, even after exposure to doses as high as $1 \cdot 7 \times 10^{18}$ pairs of ions/c.c., or more than 2,000,000 r. (surface dose).

(*b*) *α-rays.* The ionic yield, in the case of X-rays, suggests that the radon β-rays probably account for less than 5 per cent of the total effect of the $\alpha + \beta$-radiation. We have verified this fact directly, using only the action of the β-radiation, α-rays being stopped by a vial of thin glass containing the radon and directly immersed in the titanium reagent. When water was exposed to the α-radiation from dissolved radon and its disintegration products, the following results were obtained. In water completely freed from gas and therefore containing no oxygen which could take part in the reaction, the ionic yield of hydrogen peroxide was found to be the same as in oxygen-saturated water. The same result was obtained when polonium α-radiation was used; but the experiments in this case were complicated by the catalytic effect of the radio-element, which tended to decompose the hydrogen peroxide produced. When initial radon concentrations of 1–3 mc./c.c. were used, the ionic yield was independent of the dose within the whole interval tested (Fig. 2). (The ionic yield is,

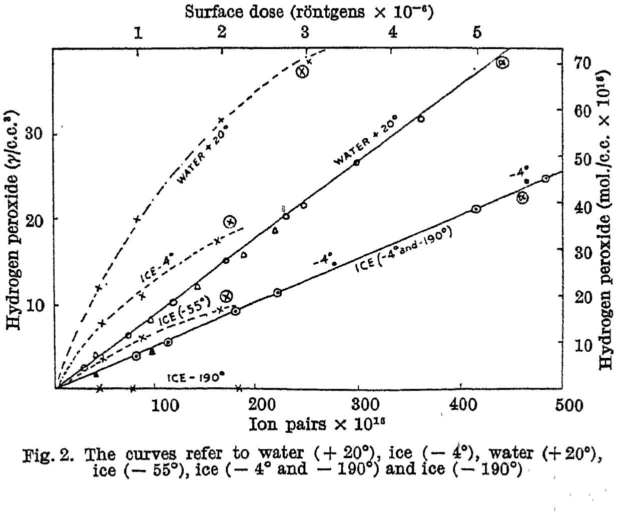


Fig. 2. The curves refer to water (+ 20°), ice (− 4°), water (+ 20°), ice (− 55°), ice (− 4° and − 190°) and ice (− 190°)

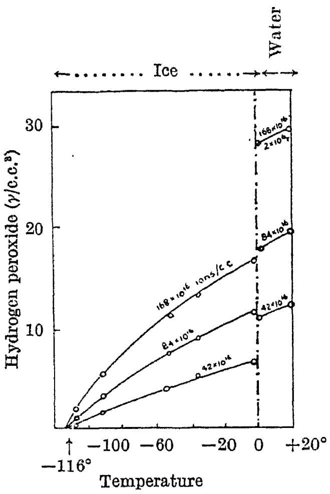


Fig. 3. Influence of temperature. The doses of radiation (reading from the top) are 168, 84 and 42 × 10^{16} ions/c.c. for ice; and similarly for water

of course, generally defined as the ratio of the number of molecules decomposed to that of ion pairs produced; this definition is not applicable to hydrogen peroxide formation, because the number of water molecules decomposed is not directly known.)

Temperature Effect. (*a*) *X-rays.* In oxygen-saturated water, the production of hydrogen peroxide decreases regularly with the temperature, a definite discontinuity marking the passage from water to ice (Fig. 3). Below −116°, it is no longer possible to detect any hydrogen peroxide, even when the dose is 2×10^6 r. (Fig. 3).

(*b*) *α-rays.* The temperature seems to be without influence on the production of hydrogen peroxide in water and ice by the α-radiation from dissolved radon. At the transition point from water to ice, a discontinuity similar to that of X-rays was observed (Fig. 1). Polonium α-rays give similar qualitative results, the catalytic effect of the radio-element being considerably decreased as the temperature is lowered.

Discussion. The experimental results show that hydrogen peroxide is formed according to different mechanisms for X- or α-rays, and that the linear ion density of the radiation affects the primary reactions concerned with the decomposition of the water.

These data are perfectly concordant with the hypothesis suggested by some British workers[5] for the interpretation of the differences between the radiobiological effects of X-rays and α-rays. According to those conceptions, the principal result of the ionization of water is the production along the track of the ionizing particle of hydrogen atoms and hydroxyl radicals (Weiss), the spatial distribution of which corresponds with that of primary ion pairs (Lea and Gray).

For X-rays, the distribution is such that the hydrogen atoms remain near the hydroxyl groups, and, in the absence of oxygen, their recombination to give water is the most likely reaction. When dissolved oxygen is present, the reaction

$$2H + O_2 = H_2O_2 \qquad (1)$$

becomes possible and produces hydrogen peroxide in amounts which increase with the oxygen concentration and the temperature.

Along the trajectory of an α-particle, the hydroxyl groups remain concentrated in the centre of the ionization column and are at first isolated from the hydrogen atoms which form a surrounding sheath. The reaction

$$OH + OH = H_2O_2 \qquad (2)$$

is the most likely, and it produces hydrogen peroxide even in the absence of dissolved oxygen; the reaction seems to be independent of the temperature. The constant ionic yield for α-rays indicates that, when oxygen is present, the amount of hydrogen peroxide produced according to reaction (1) is negligible compared with that produced according to reaction (2).

From these results, it appears that hydrogen peroxide plays an important part in the mechanism of the biological effect of radiations, since its formation seems to be one of the radiochemical primary reactions produced in aqueous media exposed to ionizing radiations.

The remarkable constancy of the ionic yield with α-rays shows that the photocolorimetric method is particularly convenient for the radiochemical dosage of dense ionizing radiations such as recoil protons or neutrons.

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[1] Bonet-Maury, P., *C.R. Soc. Biol.*, **135**, 941 (1941). Latarjet, R., *C.R. Acad. Sci., Paris* (1942).

[2] Bonet-Maury, P., and Frilley, M., *C.R. Acad. Sci., Paris*, **218**, 400 (1944).

[3] Bonet-Maury, P., *J. Chem. Phys.*, (1942).

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NATIONAL INSTITUTE OF INDUSTRIAL PSYCHOLOGY

THE annual conference of the National Institute of Industrial Psychology was held in Buxton during April 9–12, and a report has now been issued ("Psychology at Work", 1, No. 3; July 1948). Welcoming the delegates to the Conference, the chairman of the Institute, General Sir Ronald Forbes Adam, stated that everywhere in industry management is facing the fact that output must be raised if Britain is to retain its standard of life; but the re-equipping of industry is going to take a long time and some means must be found of achieving the goal more quickly. It has now been generally realized that this increase in output can be achieved if greater attention is paid to human relationships; but there has been too little research into this problem. The aim of the Conference was to discuss some of the fundamental issues of human relationships, and its purpose can be summed up in three questions: (1) How much knowledge on the subject exists? (2) Is the knowledge readily available and is it being utilized? (3) What research can be undertaken?

The first session of the Conference was grouped under the heading "The Man and the Job" and, in the first address, Mr. Robert Watson, chief personnel officer to the Philips group of electrical companies, discussed the selection and allocation of workers. In a recent attempt to check selection and placement practices in industry, Mr. Watson and his colleagues sent out a questionnaire to about two hundred firms in many industries. Replies were obtained from sixty-three firms, including a high proportion of the acknowledged better employers, employing altogether about 300,000 persons. Of the sixty-three firms, four employed full-time psychologists; fifty-two did not give special training to employment interviewers and fifty-three companies did not use job specifications. Forty-eight companies did not give dexterity tests to hourly-paid operators, and fifty-three companies did not give intelligence tests to hourly-paid operators. From this and other data supplied by Mr. Watson it seems reasonably certain that few companies are taking advantage of the latest psychological developments in the use of selection methods. If companies could be persuaded to make use of modern employment practices it would do much to reduce the heavy burden of labour turn-over costs which help to inflate the price of the finished article. While it is not easy to obtain the costs of labour turn-over in any one industry, figures obtained from a firm employing 4,500 females and 3,380 males on mass production work showed that there is a labour turn-over in 1947 of 56 per cent of the total female hourly-paid workers and 38 per cent of the male workers; of those who left the firm during the year, 67 per cent of the women and 72 per cent of the men were in their first year of service.

In a paper on training and working methods, Colonel B. Ungerson, chief psychologist, Directorate of Manpower Planning at the War Office, described the methods which give best results in providing training for unskilled and semi-skilled jobs. Instead of the existing method of placing a newcomer with an experienced operator and telling him to get on with the job, Colonel Ungerson suggested that the efficiency of a department would be considerably improved if newcomers were given definite training under competent instructors. This training should include the presentation of knowledge which would include the most suitable tools for the job, when they were satisfactory for use, what raw materials were used for which jobs and so on. This should be supplemented by as many practical aids as possible, including diagrams, models (or the real thing if possible) and a museum of faults; these should apply both to raw materials and finished products. The problem of developing skill is to ensure a repetition of good movements until they become habitual; this should be based upon movement study and is not necessarily complex. Colonel Ungerson then gave some examples of how skill could be developed in various unskilled and semi-skilled jobs.

Following the papers by Mr. Watson and Colonel Ungerson, the Conference divided into eight discussion groups which reported their findings to the Conference at the end of the first day. Summing up the findings of the groups, the chairman, Lord Piercy, said that we are faced with the problem of more production with a given labour force. We can only cut our costs by three means: education, application of what is known, and research. In the field of the education of management we are not yet getting the full benefit out of good practice and, although there will be 'sales resistance' all the way down the management chain, we must get the practice of good firms accepted by others. In the application of particular items of information he was impressed by the stress which has been laid on training as opposed to selection. Training undoubtedly is the key to prompt results, but the individual as a whole should be considered, and here selection is important. On the subject of research it is necessary to pool all our ideas. The problem of the use of individuals of low mentality might profitably be pursued further, and it is pleasing to report that over the last year the Government has come to realize the importance of this work; Panel 3 of the Committee on Industrial Productivity was specially charged with the consideration of the human factors affecting production.

The second session was grouped under the general heading, "The Firm as a Working Unit". Mr. Graham Satow, director of training, Stewarts and Lloyds, Ltd., in a paper on the supervisory grades, traced the development of a changed outlook among workpeople and into this background fitted the position of the foreman and his problems. The same difficulties seem to be encountered on both sides of the Atlantic, and he suggested that the two aims should be to strengthen the foreman's status in the firm and to develop a changed pattern of leadership in the supervisory grades. Mr. Satow then made many practical suggestions as to the methods in which these aims could be realized.

Probably the highlight of the Conference, however, was the paper by Mr. W. L. Mather, director of Mather and Platt, Ltd., on communication within the firm. Borrowing from his experience at the Army Staff College, Mr. Mather gave a practical demonstration of the way in which two-way communication could take place within the firm. Two boards were placed in front of the audience, one of which was marked "Management" and the other "Workers". Between these two there was a gap which, he said, represented the gap between management and workers about which so much was being talked at the present time. The problem is to bridge the gap. Very useful bridges across the gap are provided by personnel departments, works committees, joint production consultative and advisory committees, general committees, training, notice boards, broadsheets, magazines, suggestions schemes, lectures and verbal instructions. These bridges can easily be broken, however, and with a compelling dramatic presentation in which he was helped by a typical British workman, Mr. Mather showed how the only real way of providing communication in any firm is by personal contact.

After further discussion, the second session was summed up by Sir Godfrey Ince, permanent secretary to the Ministry of Labour and National Service, who stated that he was glad that the Conference emphasized the problem caused by the changed outlook of the worker. To find the right relationships between the man and the job involves using the right methods of selection, training and allocation, and use can be made of the Ministry of Labour's experience both with the Juvenile Employment Service and in providing supervisory training through the Training within Industry Scheme.

The final address to the Conference was given by Mr. Austin Albu, deputy director, British Institute of Management, who said that it is the variation between firms which has to be considered when approaching our industrial problems. Some British firms have employed methods which equal those of any other country, and the need is to bring all firms as near as possible to this standard. This can be done, first, by selling ideas to management; secondly, by breaking down the resistance of trade unions and abolishing restrictive practices generally; and thirdly, by training first-line supervisors. The Conference has profitably discussed ways in which these things can be done, and it is hoped that the British Institute of Management will soon be able to be of direct service to industry.

T. H. HAWKINS

FORTHCOMING EVENT

Thursday, September 9

University of Manchester (in the Physical Laboratories, Manchester).—Discussion on "Meteors" (to be opened by Dr. F. L. Whipple).

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned :

Assistant Lecturer (temporary), and a Demonstrator, in the Department of Botany—The Registrar, The University, Leeds 2 (September 10).

Demonstrator in Chemistry and Biochemistry with a special interest in Physical Chemistry—The Dean of the Medical College, St. Bartholomew's Hospital, West Smithfield, London, E.C.1 (September 11).

Assistant Lecturers (3) in the Department of Civil Engineering, to assist in the subjects of Theory of Structures and Fluid Mechanics—The Professor of Civil Engineering, City and Guilds College, South Kensington, London, S.W.7 (September 13).

Lecturer (woman) in Geography, and an Assistant Librarian (man or woman)—The Warden, Goldsmiths' College, New Cross, London, S.E.14 (September 14).

Technical Assistant (man or woman, Grade B) for experimental research work in the Zoology Department—The Registrar, University College of North Wales, Bangor (September 15).

Lecturer in Experimental Pharmacology—The Secretary, The University, Aberdeen (September 15).

Lecturer in Botany at Farouk I University, Alexandria—The Director, Egyptian Education Bureau, 4 Chesterfield Gardens, London, W.1 (September 15).

Research Officers (4), Assistant Research Officers (5), and Research Assistants (3), in the Board of Trade—The Secretary, Civil Service Commission, Burlington Gardens, London, W.1, quoting No. 2267 (September 16).

Research Assistant (with Honours Degree in Botany and, if possible, some practical experience in Horticulture) to work on Strawberry Breeding—The Secretary, School of Agriculture, Cambridge (September 25).

Assistant Lecturers (2) in Anatomy—The Secretary, University College, Gower Street, London, W.C.1 (September 25).

Deputy Curator at the Horniman Museum, London Road, London, S.E.23—The Education Officer (Estab/2), County Hall, Westminster Bridge, London, S.E.1 (September 30).

Controller of Telecommunications, Civil Aviation Branch, Air Department, Wellington—The Office of the High Commissioner for New Zealand, 415 Strand, London, W.C.2 (September 30).

Lecturer in Electrical Engineering at the University of the Witwatersrand, Johannesburg—The Secretary, Universities Bureau of the British Empire, 32 Woburn Square, London, W.C.1 (October 1).

Technician to take charge of Medical Unit Laboratory—The Secretary, St. Mary's Hospital Medical School, Praed Street, London W.2 (October 1).

Lecturer in General Bacteriology, and a Research Assistant and Demonstrator (temporary) in Botany—The Registrar, University College of South Wales, Cathays Park, Cardiff (October 2).

Chair of Experimental Physics, and an Assistant Professor of Experimental Physics, in the University of Geneva—Le Conseiller d'Etat charge du Departement de l'Instruction Publique, 6 rue de l'Hotel-de-Ville, Geneva, Switzerland (October 15).

Readership in Physiology at St. Bartholomew's Hospital Medical School—The Academic Registrar, University of London, Senate House, London, W.C.1 (October 18).

Studentships (4) at a British (or, exceptionally, foreign) research institute in preparation for Fisheries Research in the Colonial Empire—The Under-Secretary of State, Colonial Office, Research Department, Sanctuary Buildings, Great Smith Street, London, S.W.1 (October 31).

Senior Lecturer or Lecturer in Chemistry at Canterbury University College, Christchurch, New Zealand—The Secretary, Universities Bureau of the British Empire, 32 Woburn Square, London, W.C.1 (November 1).

Readership in Physics (in the field of Metal Physics) at University College—The Academic Registrar, University of London, Senate House, London, W.C.1 (November 4).

Lecturers in Physics, a Lecturer in the Department of Mathematics, and a Senior Assistant in the School of Chemistry—The Registrar, College of Technology and Commerce, The Newarke, Leicester.

Inspector of Mines (to act also as Inspector of Quarries and Explosives and Technical Adviser to the Mining Board) in the Department of Lands, Mines and Surveys, Fiji—The Director of Recruitment, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

Botanists (to undertake the improvement of economic plants by selection and breeding, and to investigate and control plant disease) in Nigeria—The Director of Recruitment, Colonial Service, Sanctuary Buildings, Great Smith Street, London, S.W.1.

Senior Technicians (2) in the National Blood Transfusion Laboratory, Cardiff—The Regional Blood Transfusion Officer, 19 Newport Road, Cardiff.

Senior Laboratory Steward (Chemistry and Biology)—The Bursar, Merchant Taylor's School, Sandy Lodge, Northwood, Middx.

Laboratory Assistant—The Headmistress, Godolphin and Latymer School, Hammersmith, London, W.6.

Laboratory Assistant in the Chemical Laboratories—The Principal, County Technical College, Stoke Park, Guildford.

Laboratory Technician—The House Governor, Skin Hospital, John Bright Street, Birmingham 1.

Lecturer in Chemistry to Intermediate B.Sc. stage—The Principal, Medway Technical College, Gardiner Street, Gillingham, Kent.

Lecturer in the Natural Philosophy Department—The Secretary, Royal Technical College, Glasgow.

Assistant Lecturer in Agriculture, and a Demonstrator in Chemistry—The Registrar, The University, Nottingham.

Principal Medical Officer/Research (bacteriologist with good experience of original research), a Principal Scientific Officer (bacteriologist with good experience of original research), a Principal Scientific Officer (biochemist with first- or second-class honours degree and good experience in original research), and Medical Officers/Research (bacteriologists or experimental pathologists with experience of original research), in the Microbiological Research Department of the Ministry of Supply—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2274.

Biochemist to undertake establishment and direction of biochemistry research and development laboratory in Serum Institute, Naples—The Secretary, Wright-Fleming Institute of Microbiology, St. Mary's Hospital, Paddington, London, W.2.

Engineer specializing in drilling and blasting operations (Ref. TT.76), an Engineer specializing in shaft sinking and tunnelling operations (Ref. TT.77), and an Engineer specializing in mechanical stowage (Ref. TT.78), in the Production Department in London—The National Coal Board, Establishments (General) Branch, Hobart House, Grosvenor Place, London, S.W.1, quoting the relevant Ref. No.

Agricultural Chemist in the Agricultural Department of the Government of Kenya—The Director of Recruitment, Colonial Service, Sanctuary Buildings, Great Smith Street, London, S.W.1.

Senior Meteorological Officer for the Government of Falkland Islands Dependencies Survey for service in the Antarctic—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.N.21628/3E.

REPORTS and other PUBLICATIONS

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Great Britain and Ireland

The Particles in Cosmic Radiation. By Thomas E. Nevin. Pp. 54 + 3 plates. (Dublin: University College, 1948.) 3*s.* 6*d.* [76

Department of Scientific and Industrial Research and Admiralty: Radio Research. Special Report No. 17: Fundamental Principles of Ionospheric Transmission. Produced by the Inter-Service Ionosphere Bureau at the Great Baddow Research Laboratories of the Marconi Wireless Telegraph Co., Ltd., September 1943. Pp. 82. (London: H.M. Stationery Office, 1948.) 1*s.* 6*d.* net. [76

Manchester Joint Research Council. Market Research: Report of the Conference held on Wednesday, 22nd October 1947, at the Albert Hall, Manchester. Pp. 108. (Manchester: Manchester Joint Research Council, 1948.) 2*s.* 6*d.* [76

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BALANCE BETWEEN THE PURSUIT AND APPLICATION OF SCIENCE

IN title, and, to some extent, in content, Sir Henry Tizard's presidential address to the British Association (see p. 392) recalls that of General Smuts to the centenary meeting in London, though in form the outlook of the present chief scientific adviser of the Government resembles rather that of the engineer, as it was put by Sir Alfred Ewing. All three addresses glance at that Victorian era, the ideas and beliefs of which must have been made more familiar to many of Sir Henry's audience by the series of talks broadcast in the B.B.C. 'third programme' this spring. Already, however, the scientific world picture which General Smuts outlined has changed considerably, as indeed he indicated it would do; and although Sir Henry Tizard did not pursue the philosophical theme of the centenary address to the British Association, it is clear that one or two of its points were in his own mind.

Science now, as he pointed out, stands higher in the public esteem than it has ever done in Britain. The public controversy between science and religion has died down, and the recent report of the Lambeth Conference provides evidence of a changed attitude and outlook on the part of the churches assembled there that would have seemed startling indeed to the Victorians, even to those with scientific interests who gathered in Brighton for the meeting of the British Association in 1872. Indeed, the frankness, clarity and logic of that report may well astonish many men of science who have not yet realized how truly science and religion stand on the same side in the defence of freedom and the moral, spiritual and cultural values of civilization.

At these values Sir Henry, however, gave no more than a passing glance. Instead, we have been given a world picture in which the central and dominating figure is man and his activities. The world, he suggests, is passing from one state of unstable equilibrium to another, and will be unstable for many years to come. We can at least strive to balance it so that the chance of a major catastrophe is made as small as possible, and Sir Henry holds that science has much to contribute towards this aim. We should ask ourselves whether we are not claiming too much for science in some directions, and doing too little in others; and, in words that recall those of General Smuts and also those of Sir Alfred Ewing, he suggests that we should consider in fact whether the great forces of science, on the proper exercise of which all social progress depends, are in balance.

The balance to which Sir Henry addresses himself more particularly is not that between ethical and material values, between science, art and religion, but between the pursuit and the application of science. To read his presidential address is to realize the extent to which his master mind is influencing the work of the Advisory Council on Scientific Policy as revealed in its first annual report. Some of his remarks may fail to reach all the industrialists or professors or directors of research for whom they are plainly intended; but Sir Henry's position justifies the confidence that he will not fail to make those views known in any quarter that may be desired.

This part of the address is essentially a sermon on economic recovery. Sir Henry suggests that one of the lessons of the last two generations is that the decline in the prosperity of some branches of industry is due to their tendency to go on doing what manufacturers know they can do successfully rather than to launch out in new directions. Sir James Morton, for example, used to contend strongly that this was the real reason for the depression in the cotton industry in the nineteen-twenties ; Sir Henry himself suggests that this rather than the neglect of science was the real reason for the development of synthetic dyes and fine chemicals in Germany rather than in Great Britain.

But after a tribute to the quality of the reserve of scientific ability in Britain as revealed in both the world wars, and a warning as to the importance of maintaining the quality of academic research, Sir Henry puts in a timely protest against excessive drift of scientific man-power to the universities. He wonders whether we are not already over-populating the research departments of universities. Industrialists, who are looking patiently to the universities to provide the recruits to their research and production departments which they are at present unable to find may share that wonder. They may equally believe that university research departments are not the only over-populated departments, and the subsequent reports of the Advisory Council on Scientific Policy will certainly be scanned for evidence that the chairman is making his own views on the distribution of scientific man-power effectively prevail.

There need be no fear that whatever action the Advisory Council may inspire will impair the high standard of teaching in the universities or the schools of Britain, or impede the expansion of education in the higher branches of technology. We have become a scientific nation, but there is still too slight an understanding of the nature and the limitations of research ; and a main theme of Sir Henry's address is that which recurred in the annual reports of the Department of Scientific and Industrial Research before the War. Sir Henry contends that industrial prosperity will depend more and more on the continuous application of science to industrial practice. Without disparaging new knowledge or research, he points out that the first requirement at the present time is the application of existing knowledge.

The prime object of industrial research is to do something that has never been done before, or to do things better than they have ever been done before. Furthermore, all social progress, such as the spread of education, promotion of health, and opportunities for leisure and healthy recreation, must depend on the power of science and technology to increase the productivity of industry. The productivity of labour in Britain is far lower than it could be if the results of past research were more resolutely and continuously applied. Sir Henry instances building, the coal industry and textiles, and suggests that the real reason for the higher productivity of such countries as Sweden and Switzerland is not in superiority of natural resources or in the quality or quantity of scientific and industrial research, but in their higher average standard of technology and in the greater proportion of men of high scientific education in executive control of industry.

It is not the general expansion of research in Great Britain that is of the first importance for the restoration of its industrial health, and certainly not the expansion of Government research remote from the everyday problems of industry. In Sir Henry's view the immediate task should be to apply what is already known. That view will be welcomed by many for its implications in regard to the distribution of man-power ; but before considering two of these implications in particular, it is interesting to note that without using the stock term 'operational research', Sir Henry commends as one practical means of assisting the application of existing knowledge the technique used in progressive industry in technical service long before the War and developed with such remarkable success by the fighting services in the attack on problems of war.

The concluding observation in this connexion brings out the really vital factor in the utilization of science to-day. In the technique to which Sir Henry refers, far more attention is given to the study of man in relation to the machine he has to operate than in any branch of industry. Those industries which have gone furthest in that direction are precisely those in which human troubles, if not entirely absent, are most inconspicuous. In them, therefore, under such conditions, is there the best prospect of achieving that special object which all industrial research should have, namely, of reducing the labour required to supply the material needs and wants of men.

The central problem in the utilization of scientific knowledge in our economic recovery is thus that of man : of the wise use of man-power, of distribution or redistribution, and of securing the willing and intelligent co-operation essential for the full use of the new powers which applied science has given us. The importance of the work of the committee on human factors concerned in industrial productivity, of which Sir George Schuster is chairman, could scarcely have been better emphasized. Although Sir Henry's direct responsibilities in that field have now ceased, it seems certain that the work initiated by the Committee on Research and Productivity will continue to be watched by him with interest and firm support.

On the material plane, subject to the qualifications already indicated, Sir Henry takes a hopeful view of the future. He is reassuring on the question of food supply, but points out that it is on the development of the biological sciences that the peace and prosperity of the world depend. He considers that, so far as Great Britain is concerned, we must plan our economy on the assumption that food will be both scarce and dear for many years to come ; and the answer to the question how long depends less on the ability than on the will of man.

"Science", said General Smuts at the centenary meeting of the British Association, "has come to represent the growing point of the human advance. It stands for the new forces which are re-shaping this world of ours. It faces the future with a bold and confident spirit. It has an invincible faith in truth at all costs; and in that faith it is embarked on the endless adventure which carries the future of the human race."

In seventeen years we have lost something of that confidence in science, and in spite of the respect to which Sir Henry Tizard rightly referred, there have been new doubts as to the sufficiency of science. Science alone, it is widely held, is not enough; and in the world of science there are many who believe with the Lambeth Conference that technical discovery must be brought into line with ethical direction. Sir Henry Tizard recognizes that we live in difficult times, but it is from Whitehead rather than Smuts that he draws his inspiration when he urges that it is a time for adventure, for taking calculated risks.

Sir Henry's contacts with the universities and with industry have convinced him that the spirit of adventure in science is as lively as ever it was. He looks forward to the future in the belief that by finding the right way to combine originality in science with enterprise and speed in its application, the nation can climb from the depths of bankruptcy to new and unsurpassed heights of prosperity and influence. Some successor in the presidential chair may or may not have occasion to refer to the great influence of the work of a few young men, who are now unknown to the public. Sir Henry's audience will look forward to that future with the greater confidence, because one whose foresight did so much to prepare our scientific resources for war is in the position to influence as potently their ordering for the tasks of economic recovery and of peace.

PLANT COMMUNITIES

The Study of Plant Communities

An Introduction to Plant Ecology. By Prof. Henry J. Oosting. Pp. 389. (San Francisco: W. H. Freeman and Co., 1948.) 4.50 dollars.

SINCE plant ecology first started, as a distinct division of study within the major science of botany, with the publication of Warming's "Plantesamfund" in 1895 (first German edition in 1896 and an English edition, "Oecology of Plants", Oxford, 1909), it has owed much of its rapid growth to American workers. In particular, the concept of succession was clarified and systematized, if not conceived, in the United States, and its development has been stimulated and largely directed by the researches, terminology and theories of American ecologists. It is therefore to be expected that textbooks of ecology intended primarily for American students should record progress periodically. Such works naturally have both peculiar value and particular limitations for students in other countries. They direct attention to points of view and literature which might otherwise be overlooked and to examples which might remain unknown. On the other hand, it is not always easy to evaluate the conclusions reached because of unfamiliarity with both the flora involved and the field conditions.

The book under notice covers fairly adequately the subject of plant communities or synecology as an introduction to a part of plant ecology. After a preliminary discussion on the subject-matter of ecology there are five parts, with a total of eleven chapters, dealing with the plant community, factors controlling the community (the environment), community dynamics and practical considerations. A useful distinction is made early on, and emphasized several times later, between a concrete or specific example of a community and the abstract community as a synthetic idea derived from a study of several or many concrete examples or stands. Terminology is introduced gradually in the text and nowhere overwhelms the reader. Divergent points of view are judiciously treated. For example, the description and classification of communities, as developed especially by European writers, is contrasted with the view of vegetation as changing by development from origin to climax. Yet "each method has its place and usefulness. In fact each has profited from the other, but since the dynamic point of view has the broadest usefulness in both pure and applied ecology, it will be emphasized here." Importance is rightly given to the need for quantitative data in vegetational analysis. Refinements of the quadrat method, density, frequency, cover and space are considered. Qualitative characters, including sociability, dispersion, vitality, stratification, and periodicity, and "synthetic characteristics", such as presence, constancy, and fidelity, are discussed.

Considerable space is devoted to describing the factors controlling the community and the methods of measuring them and their influence on vegetation. Climatic, physiographic (mainly soil), and biological factors are dealt with in four chapters. The treatment accorded is on the whole adequate and up to date so far as American research is concerned, but would have been improved by the inclusion of European research, especially on 'biological' (or better, 'biotic') factors. The account of plant competition, for example, could have been much improved by reference to published researches on British vegetation.

A concise account of plant succession is followed by a very useful chapter on the distribution of climax communities in North America. This summary of the principal vegetational features of the continent is likely to be welcomed by many students of plant geography. The chapter on shifts of climaxes with time suffers from having only very brief references to work done outside North America, and from overcondensation, especially of the subject of pollen analysis.

The final chapter, on applied ecology, is to be commended as linking up scientific investigations with the satisfaction of human needs in the practices of forestry, agriculture, conservation, water supply, and what is termed 'landscaping'. The extent of this chapter could have been enlarged with advantage.

The book is illustrated with 190 figures. These are mostly well-chosen and fairly well-reproduced photographs, but include some outline drawings. There are also a number of tabulations. Besides "General References" at the ends of chapters there is a list of 276 "References Listed". The vast majority of the references are to American publications. It is, for example, surprising to find only two or three references to papers in the *Journal of Ecology*, which was not only the pioneer of ecological periodical literature but has always been and is still in the first rank. There is an adequate index.

A general criticism, which has already been indicated, is the relative neglect of non-American investigations. One would naturally expect emphasis to be given to American work and examples to be chosen largely from North American vegetation; but more consideration of various methods of study, both of vegetation itself and of the factors of the environment, which have been developed in Europe and elsewhere would have added greatly to the value of the first half of the book. It is also unfortunate that, in common with many other text-books of ecology, the dependence of good ecological work on the correct determination of the organisms composing the communities studied is not stressed.

W. B. TURRILL

LOCAL GENII OF BRITISH FOLK-BELIEF

The Minor Traditions of British Mythology

By Lewis Spence. Pp. 176. (London: Rider and Co., 1948.) 16*s.* net.

THIS volume is an attempt to present in concise and summarized form some of the lesser facts and circumstances of British mythology which, although dealt with in some detail by writers in the more specialized journals devoted to folk-lore, have not yet received adequate attention in more popular books. It has been Mr. Spence's object to collect together many of the more local British traditions as they are expressed in legend and folk-tale, and show how the rivers, mountains, lakes and wells are peopled by a motley collection of goblins and demons, giants and monsters, vegetation spirits and supernatural birds. To the stories concerning these monsters the author has added the legendary material which has collected in such quantity around the standing stones of Britain and the dolmens and menhirs which can be treated with them.

It follows from the plan designed by the author that a good deal of the material with which he deals is concerned with those local genii and solitary spirits who rarely seem to have attained more than a local distinction, but who, in many cases, can be linked up with more prominent mythological figures.

Having discussed the spirits which are connected with British rivers, lakes and wells, Mr. Spence proceeds to give an interesting account of mermaids and seal-folk, and then goes on to discuss the giants and ogres of England. He is of the opinion that many of these gigantic divinities were the original deities of this island; and from the passages he quotes it would seem that at one time Britain must have been the home of many giants, some of whom were guilty of exceedingly unpleasant habits. Passing in review the giants of Scotland, Ireland and Wales, Mr. Spence then continues his narrative by an account of British goblins and demons, a chapter which could, I think, have been considerably enlarged with great advantage to the reader. The author points out that what he calls the demonology of Britain is the equal of any to be found in Europe, and although it does not present the number of fantastic varieties to be found in Germany, the type is broader, owing perhaps to the great admixture of stocks which makes up the British population. How far this is true it would be difficult to determine without a much more detailed examination of the legendary figures and their possible sources than has been attempted here. What is clear is that British goblins have appeared in numberless forms, many of which were described by Scot in his famous sixteenth-century book on witchcraft. Here will be found a catalogue of sprites listed under such names as bull-beggers, sylens, pans, kit with the cansticke, calcars, the hell-waine, the puckle "and such other bugs". Mr. Spence rightly points out that few of the types listed by Scot are actually of British provenance, while others are of the fairy class to which, in the present volume, the author has not turned his attention.

In the discussion of these curious demonic figures some of them are compared with so-called poltergeists, inasmuch as a few were noted for their tricks and troublesome antics. Thus the Hedley kow seems to have been of this type, for it would disguise itself as a truss of straw, and when someone tried to pick it up it would become so heavy that it would have to be laid down to let the bearer have a few minutes rest. Thereupon it would suddenly come to life and shuffle away with a peal of laughter.

It would be of interest to discover whether legends of this sort can be in any way linked up with the many accounts of poltergeist activity to be found in Great Britain. In the present volume, however, Mr. Spence has confined himself to a bald statement of the facts, and the reader is often left with a desire to know more just when his attention is directed to a fresh case. Indeed, the author might have been wiser had he not attempted to deal with so much material in so small a space. In its present form the book is little more than a very convenient and useful summary of the subject; but it would have been much improved if the dates of publication had been added to the material listed under the references, and the index much enlarged so as to include more of the proper names, and not only a certain number of them based on a method of selection the principle of which does not seem to be at all clear.

E. J. DINGWALL

THE GRADUATE IN INDUSTRY

The Graduate in Industry

By Dr. Percy Dunsheath. Pp. x + 276. (London: Hutchinson's Scientific and Technical Publications, n.d.) 10*s.* 6*d.* net.

THIS book is a thoroughly competent piece of workmanship which to some extent breaks new ground in that, unlike most 'careers' books, it indicates the trend of numerous occupations for university-trained men and women in industry and attempts to demonstrate the opportunities for service to the community which lie therein. In this his first objective, Dr. Dunsheath sets out deliberately to overcome some of the prejudices against entering industry which, according to Sir Lawrence Bragg and others, are sometimes manifest among students. While thus endeavouring to satisfy the ideals which often influence such students, Dr. Dunsheath remains essentially factual and has assembled a considerable amount of information not otherwise accessible in one volume, which should make his book of real value to the university appointments boards and to the higher appointments officers of the Ministry of Labour and National Service.

In his preface, however, Dr. Dunsheath indicates a second objective. He attempts to show both the need for a change of approach in university teaching for students destined for a life in industry, and that the new conditions of the present day may be adequately matched to the tradition of the university as a place where young people find a philosophy of life which remains with them to guide and strengthen them throughout the conflicts of life which lie ahead. Here Dr. Dunsheath has much to say that is stimulating and sometimes provocative, but he writes with insight as well as with a deep sympathy with the social aspirations that so often colour the ideals of students which will commend his book to them, no less than to those responsible for determining the trend and content of university teaching.

Dr. Dunsheath's book from the first point of view gives a fair indication of the structure on which the attempt to obtain quantitative estimates of the future demand for graduates should be based. Here his book is as important to the industrialist as to the appointments boards which attempt to prepare those estimates. Some chapters, indeed, are almost specifically addressed to the industrialist: if there are graduates prejudiced against entering industry there are also industrialists prejudiced against employing graduates in some at least of the fields which Dr. Dunsheath indicates. He gives some attention to the question of the man of science as administrator, and not only here but also in other places he emphasizes the importance of the student taking full advantage of the opportunities which a university offers to broaden his mind and outlook and enlarge his contacts with men and women. All the weight of his experience is thrown against the narrow bookish conception of education, as it is against premature or excessive specialization.

As might be expected in a book of this size, some parts of the wide field are surveyed rather sketchily, and Dr. Dunsheath would be the first to admit that he initiates rather than exhausts either discussion or description. Nevertheless, he has given a fairly clear statement of what is involved in the present discussion on the expansion of the universities, and his book should not be without value to those also who are endeavouring to see that a reasonable balance is achieved between the numbers of university-trained men and women who enter industry and those entering the universities and the public services. For its price, the printing and production might well have been better; its usefulness would be increased if it could be issued in another edition at half the price.

R. Brightman

SEA WAVES AND SURF

Wind Waves at Sea, Breakers and Surf

By Henry B. Bigelow and W. T. Edmondson. (United States Navy Department: Hydrographic Office: H.O. Pub. No. 602.) Pp. xii + 177 + 24 plates. (Washington, D.C.: Hydrographic Office and Government Printing Office, 1947.) 2.80 dollars.

SEA WAVES are as unruly as ever; but their characteristics are becoming more predictable as knowledge accumulates. The pioneer work of Arago and Stevenson was energetically extended by the American army engineer Gaillard, whose book on "Wave Action" published in 1904 has recently been reprinted. The aim of theory has always been to extract from the reality simpler ideas that are comprehensible; that real sea waves are complicated is sufficiently evident from the stereophotographs and contour diagrams prepared in 1939 by Schumacher. The first mathematical guess at the nature of a sea wave was made by Gerstner in 1802, and the later theories, most notably those of Stokes and Rayleigh, have provided a sound basis for the work of the physicist and engineer.

The appearance, therefore, of a book by Henry B. Bigelow and W. T. Edmondson is particularly welcome because of the extensive work on waves that has been done since 1940. It is described in the preface as a popular book; but the reader may take notice that it contains too many facts to be easy reading for the landsman. It aims at being a simple comprehensive account of wind waves written for the seafaring man. For this reason it is not a text-book, and the authors present only the general findings of theory supported by numerous practical illustrations taken mainly from the seaboards of North America. This practical bias is very desirable in a science which has such practical applications. The European reader may find difficulty in appreciating the practical examples and applying them to his home waters, unless he is provided with a good atlas of the American lakes and seaboards. The book is illustrated by 57 photographs and diagrams and contains 37 numerical tables with a sufficient number of selected references.

A notable feature of the book is an atlas of the frequency of occurrence of high seas and low seas and of high swells and low swells in all the major oceans during summer and winter. This atlas is one result of the military demands of the Second World War; it may prove to be of value to commerce, since such information is needed in the construction of new harbours and other engineering ventures that are exposed to the sea, as, for example, certain new oilfields. This atlas is the only one available as yet to the public.

The first four chapters describe the character of waves at sea, their growth under wind and their propagation away from the storm as swell. The last three chapters describe how waves change their behaviour when approaching the coast, due to shoaling water, to refraction around islands or headlands or to the effect of tidal streams, and describe the different types of surf which form on various beaches. The complicated effects are rationalized in a pleasing way, and these chapters deserve the attention of all maritime engineers. Though the discussion of theory is avoided, the numerous practical observations will suggest useful lines of work to the specialist. Is the grouping of waves, for example, as fortuitous as it might seem, for if fifty or more successive waves are observed by a ship, could not the next one be predicted with fair certainty? When a moderate swell is partly beaten down by an opposing wind, in what form does it emerge? Is its wavelength increased or diminished or does it merely show a reduced height?

As a correction of fact it may be pointed out that in 1911 Rayleigh deduced that waves would show a small decrease in height as they first approached shallow water, so this is not a recent discovery.

The authors give no space to the description of modern wave-measuring instruments or to techniques such as frequency analysis which are advancing the science. These subjects would find a place in a specialist's text-book, and it is to be hoped that the authors will compile one, since the present book meets its own purpose so well.

N. F. Barber

FREE RADICALS IN CHEMISTRY

The Chemistry of Free Radicals

By Dr. W. A. Waters. Second edition. Pp. viii + 296. (Oxford: Clarendon Press; London: Oxford University Press, 1948.) 20*s*. net.

DURING recent years it has become increasingly evident that free atoms and radicals, chemically very reactive but physically quite stable, play an important part as intermediates in chemical reactions. Thus the equation of a chemical reaction, as usually formulated, is very often merely the sum of many separate equations involving their short-lived substances, and a knowledge of their properties and reactivity is necessary if we are to understand the mechanism of the reaction as a whole. Consequently there has arisen in the last two decades a new kind of chemistry, no longer bound by the usual valency rules—the chemistry of free radicals. Dr. Waters' book surveys in a general way the whole of this rapidly growing subject.

The second edition, which has just been published, is identical in subject-matter with the first, published two years ago, but several minor alterations have been made and references to work published in 1947 are included. The approach to the subject is that of an organic chemist interested in understanding better the well-known reactions of organic synthesis. Physical methods of investigation, such as spectroscopy and mass spectroscopy and the results of theoretical chemists on free radical structure, are therefore omitted, although there is a fairly detailed chapter on the use of magnetic properties of free radicals as a means of diagnosis. After a general and historical introduction on the methods of production and detection, there are chapters on resonance-stabilized radicals of the triphenylmethyl type, the gas reactions of free atoms and the reactions of alkyl and aryl radicals and radicals containing other elements than carbon and hydrogen. These labile molecules are seen to be of common occurrence in a wide variety of chemical reactions. There follows an account of photochemical decompositions and the free radical mechanism of polymerization and oxidation. Finally, the subject is carried into the field of biochemistry, and the free radical mechanisms of biological oxidation are critically discussed.

The book is complementary in many ways to Dr. E. W. R. Steacie's "Atomic and Free Radical Reactions", first published at about the same time. Dr. Steacie is particularly concerned with the kinetics of the reactions of the simple free radicals mostly in the gas phase, and gives a very detailed and comprehensive account of these reactions and their associated activation energies in so far as they are known. Dr. Waters, on the other hand, presents a more general and very readable account of a wider field and devotes more attention to reactions in solution. Each author is therefore writing particularly about that part of the subject to which his own research has contributed much.

Apart from the value to research workers in this relatively new branch of chemistry, Dr. Waters' book will be read with interest by a much wider public who want a general and lucid account of a subject which has applications in so many other branches of chemistry and biochemistry. In particular it will be of great interest to organic chemists in presenting a means of understanding better what are now almost classical methods of organic synthesis and preparation.

The Oxford University Press is to be congratulated on the production of this volume at the sort of price which is becoming rare in scientific literature. It is unfortunate that there is no term in the publishers' vocabulary with a meaning between 'new edition' and 'reprint' or 'new impression', for volumes of this kind which, though technically second editions, are not sufficiently changed to make their purchase necessary by owners of the first. In the absence of such a distinction a second preface or publishers' cover note indicating what changes have been made would be of value.

George Porter

STELLAR ASTRONOMY

An Outline of Stellar Astronomy

By Peter Doig. Second edition, completely revised. Pp. vii+168. (London: Hutchinson's Scientific and Technical Publications, 1947.) 10*s*. 6*d*. net.

THIS little book is designed, as the author unassumingly states, for readers who have "slightly more knowledge than that necessary for perusal of 'popular' astronomical literature". It is, in fact, a useful summary, remarkably complete for its size, of the present state of knowledge, and there will be many genuine astronomers, both amateur and professional, who will find it worth reading for the facts and opinions which it reports.

It is not, however, a text-book, and although it does not claim to be one it must be said that it would have been even more useful if it had approached the text-book ideal more closely in some respects. In particular, although the facts, and the conclusions from arguments, are clearly stated, the arguments themselves are frequently so much compressed that they lack clarity; no one, for example, who is not already familiar with Trumpler's work on open clusters and interstellar absorption will be likely to grasp the argument summarized on p. 28. In some places compression has resulted in actual errors; thus it is stated that the υ-component of proper motion is caused by the sun's motion, and in the formulæ for mean parallaxes based on the υ and τ components no mention is made of the fact that with the former the means are algebraical while with the latter they are arithmetical; also the sign of υ is not defined, but appears to be opposite to the usual convention. These two are almost the only formulæ presented in the body of the book, and they are not actually usable as presented.

There are a number of good appendixes, mostly devoted to formulæ; one on indirect methods of parallax determination omits all notice of the three methods dealt with in the book proper, which may mislead some readers. There is a short bibliography at the end of each chapter, but it is quite clear that much more extensive and detailed references could easily have been given; they obviously were used by the author, especially in the appendixes (where scarcely any are quoted), and they would also have been valuable for elucidating the arguments in the text. There are a fair number of printer's errors, but most of these are minor. In spite of such criticisms the book well deserves a place on the shelves of working astronomers, in addition to having obvious value for the readers to whom it is more specifically addressed.

R. d'E. Atkinson

Atomic Energy Levels as derived from the Analyses of Optical Spectra

Vol. 1, Section 1: The Spectra of Hydrogen, Deuterium, Helium, Lithium, Beryllium, Boron, Carbon, Nitrogen, Oxygen and Fluorine. By Charlotte E. Moore. (Circular of the National Bureau of Standards, 467.) Pp. iii+75. (Washington, D.C.: Government Printing Office, 1948.) 50 cents.

THIS is apparently the first of a series of reports from the National Bureau of Standards, Washington, and covers the elements of the first row of the Periodic Table. That very valuable book, "Atomic Energy States", by Bacher and Goudsmit, is now sixteen years out of date, and as it is not being revised this new series will eventually replace it.

The general arrangement follows closely that of Bacher and Goudsmit; but it is an improvement to have all spectra treated similarly with the ground-state of the atom taken as zero energy. This part is right up to date, including work up to late in 1947. The recent work of Edlén is fully treated, and many of his hitherto unpublished results are included. It is interesting to see the inclusion of the ^5S level of C I at 33735 cm.$^{-1}$; this has been the subject of much discussion in connexion with the energies of carbon bonds. The introduction to the series has not yet been published, and that is quite understandable; but it is a pity that a brief key is not given to the mysterious symbols (T., G.D., etc.) which appear after the references. The present circular does not contain any diagrams of term schemes; but charts of predicted terms in the spectra of some isoelectronic sequences are promised later. This work of compiling atomic energy-levels is an extremely valuable contribution to science, and these volumes will be indispensable to anyone who uses spectroscopic data. A. G. G.

Finite Differences and Difference Equations in the Real Domain

By Prof. Tomlinson Fort. Pp. viii + 251. (Oxford: Clarendon Press; London: Oxford University Press, 1948.) 25s. net.

IN his preface, the author states that this volume includes material for a course in finite differences as well as a treatment of a number of special topics. A selection of material was necessary in order to bring the work within reasonable compass, and also to follow somewhat the special interests of the author. The very large theory of difference equations in the field of analytic functions of a complex variable has been completely omitted. This has carried with it the omission of a variety of related subjects, particularly in infinite series.

The first six chapters constitute a readable account of the applications of the finite calculus to differencing, summation, the polynomials of Bernoulli and Euler, numerical differentiation and integration, and interpolation. The remaining eleven chapters are mainly devoted to a study of the linear recurrence relation, that is to say, the linear difference equation in which the independent variable assumes integral values. It is in this topic that the author's main interest clearly lies, but the powerful and elegant operational methods which are available in this field are barely touched. On the other hand, there are interesting and useful accounts of the linear recurrence relations of the first and second orders with periodic coefficients.

L. M. M.-T.

A Bibliography of Chemical Research in South Africa, 1910–1939

Compiled by Dr. Herbert Coblans. (Published for the Natal University College.) Pp. ix + 25. (Cape Town: *African Bookman*, 1947.) 7s. 6d.

THE author of this slender volume explains that the lack of bibliographical tools is a real handicap to research workers in South Africa, since the proceedings of the learned societies there have no cumulative indexes. Many of the papers listed, however, have been published in European or American journals, and chemical research is perhaps one of the best abstracted fields of work. The information given can, therefore, be of special interest only to those chemists who wish to know which publications were by South African authors. Full titles of the papers are given and the references to the publications. The classification is according to subjects in decimal order based on the general principle of increasing specialization. In each section, the order is according to year of publication. Dr. Coblans is himself a chemist, and the accuracy of the book may, therefore, be taken for granted. His position as librarian of Natal University College vouches for his bibliographical ability. It is clear from the contents of the book that chemists in South Africa are making notable contributions to research in their subject, as was, in fact, generally realized before its publication.

Studies and Essays presented to R. Courant on his 60th Birthday, January 8, 1948

Pp. viii + 470. (New York and London: Interscience Publishers, Inc., 1948.) 33s.

PROF. R. COURANT, formerly of Göttingen and now of New York, who is known to all mathematicians by Courant and Hilbert's "Methoden der Mathematischen Physik", attained his sixtieth birthday on January 8, 1948. To commemorate the occasion a number of his friends and colleagues were invited to contribute articles for a volume to be presented to him. Among the thirty-eight mathematicians who responded to this invitation are included such well-known authorities as Harald Bohr, Carathéodory, Franck, Hadamard, Kramers, Neugebauer, Pólya, and Van der Waerden. The papers cover a wide field, corresponding to the wide range of Courant's own work, and some of them are direct developments from this work. Although most of the authors are foreign, all but six of the papers are in English.

The Cathode Ray Oscillograph in Industry

By Dr. W. Wilson. Third edition, revised. Pp. xii+252. (London: Chapman and Hall, Ltd., 1948.) 18s. net.

BECAUSE of demand the present text has been off the market for some time, so the author has taken the opportunity of bringing some of the matter up to date and also of incorporating applications of cathode-ray tubes which have been recently released. Not only would radar have been impossible but also many of the measurements and controls of industry would have been impracticable without the cathode-ray tube. It has become a tool of precision and a means of display. The types available and applicable to special tasks in industry are so well treated by the author that this edition will also soon be disposed of. L. E. C. H.

THE PASSING WORLD*

By Sir HENRY TIZARD, K.C.B., F.R.S.

President of the British Association

SEVENTY-SIX years have passed since the British Association met in Brighton. Great changes have taken place in the world since then. Nothing illustrates the lapse of time more strikingly than one passage in the address of the president, Dr. William Carpenter. After referring to the expedition sent for the relief of Livingstone he added:

"While we give a cordial welcome to Mr. Stanley, let us glory in the prospect now opening, that England and America will co-operate in that noble object which—far more than the discovery of the Sources of the Nile—our great Traveller has set before himself as his true mission, the Extinction of the Slave Trade."

And nothing better illustrates the truth of the old saying that the more things change the more they remain the same than the address of the president of the Section of Engineering, Mr. Bramwell. He discussed the coal problem. He directed attention to the alarming increase in the cost of coal, which had doubled in a year. "I am aware", he said, "that the subject of coal is a hackneyed one", but the startling facts to which he referred "force us seriously to reflect upon the use and also the abuse of coal." He discussed the inefficiency of domestic fires; but said he would rather put up with the whole of our present domestic discomforts, and even with the loss of heat than resort to the stove as a remedy. "But let not users of coal remain indifferent to savings on their present consumption until those improvements are discovered by scientific men; on the contrary, let them forthwith do everything in their power to reduce the consumption to the extent to which present science and, in some instances, present practice show the consumption can be reduced."

At the same meeting the famous physiologist, Prof. Burdon Sanderson, referred to the backwardness of physiological research in Britain as compared with Germany. "If a man wants to be a physiologist", he said, "he must, as things at present stand, study medicine. There is no logical reason for this: for although medicine ought to be built on physiology, there is no reason why a physiologist should know anything about the art of curing diseases." However, it was a most encouraging sign of the times that Trinity College, Cambridge, had "condescended to provide a place for physiologists to study and labour in, from which . . . one or two valuable researches have already sprung." We shall all agree that the condescension of Trinity College has been amply rewarded. There is perhaps still room for similar acts of condescension on the part of wealthy corporations.

There is, finally, another passage in Dr. Carpenter's address which is of special interest to me. He describes how he urged on his friends in the Admiralty the importance of organising a new expedition to circumnavigate the world, and how the Royal Society followed up his preliminary inquiries with a formal request. The Admiralty agreed, and the good ship *Challenger* was then fitting out at Sheerness, and being equipped with the most modern scientific apparatus. Captain Nares had been chosen to command the expedition, and Prof. Wyville Thomson to lead the scientific staff. The reason of my special interest is that my father was the navigating officer of that famous ship.

All that the British Association set out to achieve over a hundred years ago has been accomplished. Long past are the days when the public estimation of science had fallen so low that, to use the words of David Brewster in 1830, no scientist enjoyed "the favour of his sovereign, or the friendship of his ministers;" and when an alarmed Dean of York was moved to publish a pamphlet entitled, "The Bible defended against the British Association", which attained such a popularity with Victorian churchgoers that it ran through five editions in one year. We men of science have little to complain of now. The public estimation of science stands higher than it has ever done in Great Britain. The Royal Society enjoys a prestige unequalled since the early part of the eighteenth century. The Great War, which has been succeeded by an uneasy peace, grimly demonstrated that the country whose rulers neglect science is lost; and public men in England now display a touching but alarming faith in the power of science to solve any national problem, however serious. The time is near when, as Huxley warned us over sixty years ago. science, like Tarpeia, may be crushed with the weight of rewards bestowed on her. Let us then beware, when all men speak well of us, and be critical of ourselves. Let us ask whether we are claiming too much in some directions, and doing too little in others; let us consider in fact whether the great forces of science, on the proper exercise of which all social progress depends, are in balance.

The Progress of Sixty Years

It was with some such thoughts as these that I chose the title of my address. It is taken from Dr. Johnson's well-known advice to the poor scholar in the "Vanity of Human Wishes."

> "Deign on the passing world to turn thine eyes,
> And pause awhile from letters to be wise."

I propose to pause awhile from the fashionable discussions of Science and the Community, Science and Education, and the like, and to invite you to turn your eyes on the passing world. For it is passing —from one state of unstable equilibrium to another. I say unstable, for many many years will pass before the dreams of those who look forward to a world Government which will bring not only peace but also happiness to all, will come true. But if it must be in unstable equilibrium for many years to come, let us at least strive to balance it so that the chance of a major catastrophe is made as small as possible. Science has much to contribute to this aim; but just as no man can aim a rifle accurately without a backsight as well as a foresight, so must we provide ourselves with both, if our contribution is to be worth while. The backsight is history; it can be fashioned accurately by study. The foresight can only be fashioned from our knowledge of the state of science as it exists to-day, and from what we know is possible. It cannot be so accurate as we could wish, because we cannot foretell the effect of discoveries of which we have no inkling at present.

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* From the Presidential Address, delivered at Brighton, on September 8.

My backsight shall not be too far back. In considering the future we shall not gain more by studying remote history than we gain perceptibly in accuracy by lengthening the barrel of a rifle. I shall sight, somewhat arbitrarily, from the year 1885; not 1685. It happens to be a convenient year for me, as it was the year of my birth. It happens, too, that it marks almost the close of the stagnant period of nineteenth century science, when many men thought that "our power to discover new experimental facts was practically exhausted." But new men were coming on, and new ideas were hatching. J. J. Thomson had just been elected to the Cavendish chair of physics at the scandalously young age of twenty-eight —a thing which would not be tolerated nowadays. Charles Parsons had patented the steam turbine in 1884, and demonstrated a model at the Inventions Exhibition in 1885. Gowland Hopkins had been appointed assistant to Sir T. Stevenson, the Home Office analyst, and was studying, in his spare time, the pigments of the wings of butterflies. Three years were to pass before he was able to begin his formal education in science as a medical student at Guy's Hospital. Charles Sherrington was fighting cholera in Spain and investigating its causes, and Rutherford was carrying off all the prizes at school in New Zealand. Of these great men, whom many of us had the privilege of knowing, only one is alive to-day. Sir Charles Sherrington is the oldest living president of the British Association. We send him our respectful and affectionate greetings.

It is understandable that none of these events, which in their different ways were to have a more profound effect on history and society than any legislation, or rise or fall of governments, created any public interest, except perhaps the exhibition of the turbine which was considered ingenious but wholly unpractical. In other respects the events of the year 1885 followed a normal course, judged by modern standards. There was fighting in what we now call the Middle East, which ended in the massacre of British troops, and of their leader, General Gordon. Our Russian friends were told that anxious though we were to preserve our friendship, there was a limit to patience. But the British public soon recovered from the shock of Gordon's death, and refused, so far as I can judge, to be seriously disturbed by the prospect of war. It must be remembered that they were denied the blessings of broadcasting, and other modern equipment for the ready circulation of bad news. They were far more exercised by the prospect of cholera spreading from Spain. They had reason for their anxiety, for the great majority remembered the epidemic of 1866 when 14,000 deaths from cholera were recorded. On the whole, the people of England jogged along in a deplorable state of confidence, which was, however, justified by events, for nearly thirty years of peace followed, broken only by minor wars which had no perceptible effect on the growth of material prosperity.

In 1885, after a few years of depression, during which nearly 700,000 men and women left the country to seek better opportunities overseas, the United Kingdom was still the greatest manufacturing nation of the world. An enthusiastic commentator wrote at the time that "the material greatness of the country is amazing—it exceeds that of any other Empire, Ancient or Modern. But the moral greatness is even grander . . ." Unemployment was sometimes high in particular trades, such as shipbuilding, but between 1885 and 1914 it was never alarming, and was often as low as 2½ per cent of the gainfully employed. The United States were not then serious competitors; imports of iron and steel manufactures from the United States only reached an annual value of £500,000 in 1890, but from then on steadily increased. Germany was considered a more serious competitor. In the pursuit of science she stood first among the nations, and she was applying the methods and results of scientific research to industry on a scale and with a determination that far surpassed her rivals. At the meeting of the British Association in 1885 the president, Playfair, sadly recorded that in science "Oxford and Cambridge are still far behind a second-class German University", and that "in Great Britain we have nothing comparable to the great technical college of Zurich". Germany kept her pre-eminence in applied science until 1914; but it is perhaps worth noting that she never equalled the industrial prosperity of England, judged by the test of real national income. She might have done so, had not her rulers believed that by war they could find a short cut to the happiness and wealth that could have come in the natural course of events to a hard-working and highly educated people anxious to live in peace with the world. The terrible fate of Germany is a tragedy that affects us all, the last act of which perhaps we have not yet witnessed.

Many of the numerous comforts and luxuries which are now within the reach of every diligent working man in England are the result of invention or scientific discovery in or about the year 1885. I have already mentioned the steam turbine, which by making possible the generation of electricity on a large scale provided in the most convenient form the power on which industrial productivity so largely depends. Kelvin lit his house with electricity in 1881, and the telephone was invented in 1876; but they were both scientific curiosities in 1885. The modern 'safety' bicycle first appeared upon the roads in 1885; it was the manufacture of a reliable chain that made it practical. The first Dunlop pneumatic tyre appeared in 1888; but the idea was not then wholly new. Like many other things before and since, it had been invented before its time, that is to say, before manufacturing technique was sufficiently advanced to make it practical. Edison, in 1885, was in the full tide of his inventive genius. The first talking machine had been demonstrated in 1877, and in 1885 he was busy experimenting with motion pictures. Swan, whose share in the production of the carbon lamp is well known, invented a practical process for the manufacture of artificial silk in 1883. The typewriter in its early form was then quite old; but difficulties in manufacture prevented it from becoming available in quantity until towards the end of the century. The internal combustion engine which, in peace and war, has had a greater influence on society than any invention since that of printing, was developed from Otto's experiments in 1877. The intrepid Daimler drove a bicycle powered by an internal combustion engine of his own design in 1885; and the first motor-cars were sold to the public. In the field of applied chemistry one far-reaching development to recall is the electrolytic production of aluminium in 1885. Aluminium was then a rare metal costing £18 a pound. It now costs 10d. a pound.

Thus, although the science of physics was languishing until the discovery of the electron, X-rays and radioactivity in the closing years of the century, it was a time of enterprise and progress in engineering practice. Britain prospered. In 1897, the year of the spectacular triumph of the *Turbinia* at Spithead, we exported goods to the value of one quarter of everything we produced. Ten years later we shipped overseas nearly one third of the whole national output of goods of all sorts—on farms, in mines, or in factories. If we were doing so to-day we should have little cause for anxiety. Perhaps it was this very prosperity that caused us to fall behind in some branches of industry, for when there is little unemployment and when the standard of living is obviously rising in all sections of the community, there is an excusable tendency for manufacturers to go on doing what they know they can do successfully, rather than to launch out in new directions. Is not this, rather than the neglect of science, the chief reason for the fact that synthetic dyes and fine chemicals were manufactured in Germany, rather than in their original home England ? Whatever the answer to this question, the fact remains that when war started in 1914 we were caught off our balance. We found ourselves dependent on our enemies for many essential products and instruments on which our power to make war, and to maintain health, depended. But, to everyone's surprise, we also found that the reserve of scientific ability in the country, though not large, was high enough in quality to overcome the immediate dangers with remarkable speed. Young men from the universities who had spent their time on researches of no practical importance applied themselves with success to problems often completely outside the range of their previous studies. We had the same experience in the Second World War, although fortunately we also had the foresight to prepare for some of the worst dangers beforehand. There is a clear lesson, I feel, to be drawn from this experience. Whatever may be done, in a burst of public enthusiasm, to support and promote schools of research at universities, nothing should be allowed to lower the quality ; and size, beyond a certain point, undeniably does. A research laboratory, of whatever nature, is like a living cell. Once it reaches a certain size, which may differ with the nature of the subject, it must divide or die. When a young graduate tells me, as one did recently, that he was going to do research because it got him off military training, it makes me wonder whether we are not already overpopulating the research departments of universities.

The shock caused by the exposure in 1914 of our industrial shortcomings, which had been concealed by the apparent prosperity of previous years, led to a great increase of research by industry and by Government. The National Physical Laboratory, which had been of inestimable value during the War, extended the scope of its work. The Department of Scientific and Industrial Research, which was founded in 1915, established other Government research laboratories, and encouraged the formation of research associations to serve the needs of the older scattered industries. University schools of science were greatly enlarged, and under the influence of the great men of the inter-war period there was a surge of discovery which put Great Britain in the van of progress in nearly all branches of science. We became a scientific nation. The newer industries, such as the viscose and radio industries, which had been founded on science, rapidly developed. The chemical industries took on a new and active lease of life. Germany, badly disorganised by defeat, ceased for many years to be a serious competitor in the world market.

Many of us must have felt confident that when leadership in scientific and industrial research was allied to experience in commerce and manufacture, and to skill in craftsmanship, our country would have little difficulty in maintaining its position among the nations of the world. We have been disappointed. I am referring now not to the acute difficulties of the present day, but to the general trend of events before and after the First World War, when in spite of a nearly continuous advance in national income and standard of living, Great Britain gradually lost her pre-eminent position. We cannot attribute this relative decline to the 1914 War. That War had curiously little effect on our economy. Nor can we attribute it to the world depression in the 1930's. The depression affected us much less than many other nations, for owing to the great fall of prices of food and raw material the terms of trade moved sharply in our favour. During 1930–38 the volume of exports necessary to purchase a given volume of imports was only two thirds of what it had been during 1885–1914. To what then shall we attribute the relative decline ? Shall we argue that a main cause was that research was on too small a scale, or shall we seek for other reasons ?

Research and Industry

Let us first be clear about what results we expect to come from the application of science to industry. The primary object of industrial research is severely practical. It is not to enlarge the boundaries of knowledge, or to publish scientific papers, although that may be a prerequisite or a consequence. The object is to do something that has never been done before, or to do things better than they have been done before. And it has, or should have, the special object of reducing the labour required to supply the material needs and wants of men. All social progress such as spread of education, promotion of health, opportunities for leisure and healthy recreation, must depend on the power of science and technology to increase the productivity of industry. The rate of social reform is set by the rate at which productivity increases ; and social unrest is inevitable if reform lags too far behind the advance of technology, or is pressed too thoughtlessly before it. So we must judge the effect of industrial research not merely by the new comforts and luxuries that it produces, but also by the rate of improvement of existing processes.

In Britain, which depends more than any other country on international trade, and which can continue to maintain its present population only by exchanging manufactured articles for food and raw materials, the productivity of labour is of primary importance, for unless it is as high as, or higher than, in other manufacturing countries, we shall not be able to compete in the markets of the world. And the productivity of labour in Britain is far lower than it could be if the results of past research were more resolutely and continuously applied. We find this particularly in certain industries of great importance. In the coal industry the results are painfully obvious—

the coal raised per man employed is now lower than it was thirty years ago, when nearly all coal was hewed by hand. Research on building has been intensively pursued since the Department of Scientific and Industrial Research was founded. Those responsible for its direction have not been content with the publication of papers giving the results of their investigations but have built demonstration houses for other builders to inspect and study. But are better houses now being built with less labour than twenty years ago ? I doubt it ; if not, the research has had as yet little influence on practice. The Shirley Research Institute for the cotton industry is well known for the range and excellence of its work ; but productivity in the cotton textile trades is lower than it was fifteen years ago and much lower than in some other countries. Taking British industry as a whole, productivity is far lower than in the United States. In both countries about 40 per cent of the population is gainfully employed. In the United Kingdom the proportion engaged in manufacturing, building and civil engineering, which covers the production of all capital and consumer goods (other than minerals or food) is now a little less than 18 per cent of the population. In the United States the corresponding figure is 12 per cent ; and yet in proportion to the population the volume of production is far higher than in the United Kingdom.

The causes of the relative productivity and wealth of nations are, of course, many and complex. We gained our supremacy in the nineteenth century because we excelled in engineering genius and were the first to use mechanical power on the large scale for manufacture and transport. Our population grew rapidly because we were prosperous, and it paid us to become a food importing nation because the productivity of labour in the secondary industries was so much higher than in agriculture. But conditions have changed in the course of time. We no longer have any outstanding natural advantages, and we must expect that given approximately equal skill in technology other nations with greater natural advantages will surpass us. Only by maintaining leadership in the application of science can we hope to keep our position among the great nations. So it is not surprising that the United States, and Canada, for example, with their great natural resources, and abundant supply of cheap power, should have passed us in wealth and productivity before the War. It would have been surprising if they had not. But it is by no means so easy to explain why Switzerland, which in 1885 possessed a national income per head about two thirds of that of the United Kingdom, should have equalled us in prosperity by 1939 ; or why the industrial productivity of Sweden, a country that has no coal, should have been rising so much more rapidly than ours in the years between the wars. These two countries cannot be said to possess natural resources superior to ours ; nor can it be argued that in the quality or quantity of scientific and industrial research they excel us. But I suggest that they, in common with the United States, possess a higher average standard of technology than we do, and have a much greater proportion of men of high scientific education in executive control of industry. I quote them in support of my view that it is not the general expansion of research in Britain that is of first importance for the restoration of its industrial health, and certainly not the expansion of Government research remote from the everyday problems of industry. What is of first importance is to apply what is already known.

The fact is that all really new developments of industry are the product of the work of very few men. In general, knowledge in the physical sciences now accumulates at a rate much faster than it is, or possibly than it can be, applied in industry. There is a vast amount of knowledge waiting to be used. No new discovery, in any field, is likely to have so quick and beneficial an effect on British industry as the application of what is already known. We hear, for example, of the possibility of the production of power from atomic sources of energy. I do not think that anyone will be rash enough to prophesy what discoveries of real industrial importance will result from the researches now in progress ; but I shall certainly assert that the production of power from uranium cannot bring such economic benefits to Britain within twenty years as would the practical application of known methods of economizing coal. Mr. Bramwell's advice in 1872 is still sound, and is always likely to be. Even in those fields of industy where science and development have been most in step, we find scientific knowledge far ahead of practice. In aeronautics, for example, research has shown, without any shadow of doubt, that it should be possible to design aircraft far more economical in fuel consumption than present aircraft. For the next step we need bold and highly skilled engineering rather than more fundamental knowledge : if it is successful, air transport, instead of existing precariously on subsidies, will compete on level terms with the train and ship for long-distance passenger travel. Indeed, a revolution in transport is in sight. Shall we leave it to be encompassed by other nations, or shall we show the way ? The answer depends on whether we shall encourage enterprise and adventure in engineering.

War as Applied Science

Although I have been interested in the problems of industry for many years, I have never been closely concerned with its conduct. But for much of my working life I have been intimately concerned with that peculiar business called war, which is as old as agriculture, which is subject to the most violent booms and slumps, the cause of which we do not understand, and in which the incentive to succeed is greater than any profit or ideological incentive in civilian life. There is a healthy human rivalry between the various units and companies into which the business is divided. Sometimes it may be thought that this rivalry is carried too far ; but all are working for the same cause. In my own life-time I have seen this business change from one in which the practical man considered he had little to learn from scientists, into one in which scientists are concerned with its every aspect, from policy making to the actual conduct of operations. We shall all hope that this business is moribund, and shall do our best to kill it : but in the meanwhile it is possible that other old industries have much to learn by studying the principles of its successful conduct.

In the first place, let us note that the managing directors, the chiefs of staff and commanders, are all carefully selected highly trained professional men, who have gained their experience in a hard school, and who, at intervals in their career, have had the opportunity to study, at staff colleges and elsewhere, the fundamentals of their trade. The managing directors do not have the final responsibility for policy, but have a great influence on the decisions. Secondly, the technical efficiency of the business is entrusted to a body of engineers and technologists, who have had an advanced specialized education and experience, and who are in personal contact at all levels with scientists who are concerned with research and development. This secures that in all research, however recondite, there is a practical objective, and that there is also a continuous urge to improve in detail. The scientist is primarily responsible for research, but experienced engineers take part in it. The engineer and the scientist are jointly responsible for development. But there is no part in the whole process from research to production and use that is neglected, and none in which scientific thought and influence are wholly absent. One point of special interest is that far more attention—but perhaps still not enough—is given to the study of man in relation to the machines he has to operate than in any branch in industry.

It does not need any profound research to show that the British industries that are now best standing up to the strain of adverse circumstances are those that most nearly approach the system I have described. The chemical industries, for example, have gradually developed a similar organisation over the last thirty years. Neither research nor development has been neglected, and management is in the hands of men highly educated in pure and applied science. The result is that our chemical industries are a source of great and growing strength in peace and war. Forty years ago they were far inferior to the German industries; now they have little to fear from any competitors. In the steel industry, the efforts of which now merit our admiration, it is not uncommon to find management and direction entrusted to men of the highest reputation in science and technology. Turn your eyes on any industry in the world that is similarly organised, on the steel industry of Australia, for example, or the photographic industry of the United States, or the machine-tool industry of Switzerland, and you will find that they are the best able to weather the storms and take advantage of the fair winds of trade. Further, I shall ask you to note that in such industries human troubles, if not entirely absent, are inconspicuous. This, I think, is to be expected, for most men are happiest and do their best work when new things are being attempted, and when adventure of some kind relieves the monotony of a daily routine.

It is a mistake to suppose that science advances rapidly in a war. Certain branches of science may receive a special stimulus; but on the whole the advance of knowledge is slowed. What is striking in a war is the rapid solution of practical problems by the use of previously acquired scientific knowledge and technique. It is a mistake also to attribute this success to the fact that cost does not matter. Cost matters a great deal; indeed the purpose is always to achieve the end in view with the minimum cost of lives, labour and material. Finally, all depends on good design and production. Our weakness in the War was not to be found in the judgment of what was best to do, nor in the scientific work necessary to do it. It was when the stage of design and production was reached that we fell short of the best standards. The magnetron, which contributed more to the success of the Allies than any other single invention, was a product of British science; but it had to be redesigned in the United States for economical manufacture. Penicillin, the greatest practical achievement of medical research during the War, also originated in Britain, but unless American skill in large-scale manufacture had been available, many thousands of men, who now enjoy a healthy life, would have died.

We now see history repeating itself. After the Second World War, as after the First, there is a cry for more research, in industry, and by Government, and a strong demand on the universities to expand their schools of science. Temporarily this enthusiasm is having an unfortunate effect, for the schools are getting starved of teachers; and unless a high standard of teaching is maintained in our schools, the next generation of scientists will suffer. In the long run, too, the expansion of research will fail to produce the hoped-for result unless we promote at the same time education in the higher branches of technology, and unless the technologist takes his rightful place in industry. Throughout the nineteenth century, the advances in engineering that made so great a difference to our prosperity, were the product of inventive rather than of scientific genuis. Even the steam turbine, though its conception was founded on long-established physical principles, was brought to a high pitch of practical efficiency with very little assistance from scientists. But we live in a different age. Pure invention still has its place; but industrial prosperity will depend more and more on the continuous application of science to industrial practice. Unless we can raise our standard of technology, unless there are many more men in executive positions in industry whose practical experience has been preceded by a scientific eduction, we shall inevitably fail to keep our place among the great manufacturing nations. President Playfair's remark about Oxford and Cambridge is no longer true. Cambridge has long been recognized throughout the world as a great home of science; and it is not merely devotion to my *Alma Mater* that prompts me to say that Oxford is now not far behind. But I fear that it is still true that in Britain we have nothing comparable to the great technical college in Zurich.

Advances in Public Health

I turn now to another branch of applied science, less spectacular in its results to the ordinary citizen, but far greater in the benefits that it has brought to mankind during the last sixty years. The physical sciences have given men comforts and luxuries that are obvious to all. The aeroplane, the cinema, the broadcasting and television receiver, the domestic refrigerator, and many other familiar things which were unknown even at the end of the nineteenth century, are positive results of scientific research. Health, on the other hand, is in a different category. The ordinary citizen sees little connexion between the advance of science and the fact that he is healthy; it is, he feels, a quality that other people may lack, but is his by right of a superior heredity or habit. Ill health, on the other hand, while a fault in other people, is a misfortune in himself, and a serious reflexion on the state of medical science. How many men now living in Britain have any real conception, I wonder, of the astonishing advances in the prevention and cure of disease that have taken place in the last sixty years, and of how they have come about? Where is the cholera with which I was threatened as a child if I drank unboiled water? Its last appearance in England was in 1893; it was soon stamped out, and there has been no epidemic since. We are puzzled and alarmed by its appearance even in a country like Egypt, with its low standard of sanitation. Many other diseases which were common in 1885 have practically disappeared or are under control. Those that remain, will, without doubt, be conquered in the end by the advance of knowledge.

In 1885 the crude death-rate was twenty per thousand ; now it is twelve. In 1885 one in every seven children died during the first year of life ; now the figure is one in twenty-five. In 1885 a young man of twenty could expect on the average to live for forty-one years; now his expectation of life is forty-eight years. And it is not merely that he will have a longer existence, but that he can look forward to a far healthier life. Where can one now find the stunted children with distorted limbs, who were a common sight in the industrial towns of England when I was young ? If it were possible to compare a random sample of young men and women from the poorer districts of London with their grandparents at the same age, it could scarcely be believed that they came from the same stock. Only those few medical men who had the duty of examining recruits for the Army in the First and the Second World Wars can have any vivid appreciation at first hand of the changes that have come about in a single generation through the study of nutrition and preventive medicine.

These great advances have been mainly due to the fundamental researches of very few men, and to the vigour and good judgment with which their work has been extended and applied in practice. Never has public money been better spent than on this branch of applied science ; and never has such a small investment yielded such a rich return to the nation. The recently published report of the Medical Research Council, covering the war years 1939–45, is a document of the highest scientific and historic importance which can be read with interest and profit even by laymen who are unfamiliar with the jargon of medical men. In 1939 the Medical Research Council confidently stated that :

> "The destructive power of arms will indeed have increased immensely since 1918 if it overshadows the advances in knowledge for the saving of life which modern discovery has placed at the disposal of medical men. If a strict comparison were made between what science has done to increase war mortality and what medical science has done to lessen these lethal effects, there is good reason to believe that the latter would be an easy winner."

Omit the word 'medical' in the last sentence, and I think it will be agreed that no prediction has been more amply justified. Nor should we too quickly assume that new destructive weapons evolved by physical science will in the future reverse the decision. In spite of all the hazards of bombing, the average civilian death-rate during the years of war was lower than it was during the immediately preceding years of peace. The deaths in the fighting services were less than one third of the deaths in the 1914–18 War ; and more than 80 per cent of the wounded have been restored to normal life. In spite of all the difficulties caused by the submarine blockade, and the shortage of food, which still persists, we are a healthier nation than we were in 1939. Whether we are as energetic is another question.

Our American allies have the same tale to tell. Four years of hard fighting in Europe and the Pacific caused fewer deaths than in the American Civil War, when the population of the United States was only one fourth of what it is now. It was only in Germany, East Europe and the U.S.S.R. that war counted its victims by millions, and then not through the destructive forces of science, but because of the brutality of human nature at its worst.

Nevertheless, the progress of preventive medicine is giving rise to social changes of great complexity, which will seriously affect the peace and prosperity of the world unless their consequences are studied with care, and their possible evils counteracted by wise and far-sighted action. In all countries which have a high standard of education, such as our own, the rise in population which follows a rapidly decreasing death-rate has been kept in check by a voluntary control of births. As a result the average age of the population has considerably increased, and is increasing ; the proportion of the population of England and Wales that is more than sixty-five years of age is now nearly four times as high as it was in 1885. This in itself does not yet present any serious problem, for, as the proportion of children is much less than it was, the proportion capable of productive work, between the ages of fifteen and sixty-five, is actually somewhat higher than in 1885. No fundamental difficulty, from this cause, is likely to arise for many years to come. But the population of the world as a whole is now increasing by 1 per cent a year, and its distribution is such as to make it extremely doubtful whether the supply of food can keep pace, even with the present low standard of nutrition. It is the advance of science that has made this possible. War, pestilence, and famine have kept the population within bounds since the dawn of history. War has ceased to be effective ; pestilence is rapidly losing its power ; only famine is left as a brake until education takes its place. Is famine inevitable, or will science again come to the rescue, as it has done before ? I do not think that the danger of the present position is yet fully realized, in spite of all the work and publications of the United Nations Organisation, and in our country the well-informed debates and warnings of the House of Lords. People remember only too well the apparent over-production of food in the 1930's, and forget, or do not know, that since then the population of the world has increased by some 300 million people.

A single example of what is now happening, and will probably happen on an ever-increasing scale, may help to illustrate the problem. Malaria has always been one of the most potent instruments of population control. It is endemic in most tropical countries. In the Far East it has hitherto been an antagonist more to be feared than the armed forces of an enemy. In the Second World War it was defeated by the controlled use of 'Mepacrine', a German drug, which is being replaced by an even better product of British research. In addition, the potential importance of the insecticide D.D.T. for the elimination of malaria-carrying mosquitoes began to be recognized toward the end of the War.

In 1944, Sir Robert Robinson, Prof. J. L. Simonsen, and Dr. Harold King visited British Guiana on a special mission. British Guiana has a population of roughly 400,000. Accurate statistics of the fluctuation of population do not exist; but it is probable that it has remained stationary for the last twenty years. Two thirds of the population used to live under conditions of severe endemic malaria. The birth-rate was low, and the infantile and adult mortality high.

The particular type of mosquito which is the carrier of malaria, and also of yellow fever and filariasis in the Colony, lives and breeds in the wooden houses, and not in swamps. It is thus peculiarly susceptible to attack by insecticides. The British mission advised a comprehensive trial. They were fortunate in finding a most experienced and progressive officer in Dr. Giglioli, honorary Government malariologist. Their advice was taken; operations were started in 1945, and at the time of speaking it is probable that the whole population of the Colony has been protected. The annual cost of keeping the whole district under continuous control is of the order of five shillings a head.

Malaria is now rapidly disappearing from the Colony. I cannot quote valid statistics covering the whole population; but I have been supplied with exact information about a suburb of Georgetown with a population of about 3,000, and there is no reason to suppose that the results will not apply generally. In this village the death-rate was equal to the birth-rate during the years 1938–44 inclusive. The average infantile mortality during this period was about 250 in a thousand. It rose to more than 350 in 1944. D.D.T. control was introduced in July 1945. By the end of 1947 the birth-rate had doubled, and the infantile mortality had dropped to 67 in a thousand. The population is increasing by 10 per cent annually.

Population and Food Supplies

As the new methods of preventive medicine spread—and that there will be many more to come no one can doubt—we must expect the world population to grow at an even faster rate than it has done in our life-time, unless famine intervenes. Moreover, it will grow particularly in parts of the world that already have a high density of population, such as India, where the population is now increasing by five million people a year; and Egypt, where there are already 2,000 people to every square mile of cultivated land, and where it pays to have children as they are a source of labour and of profit to their parents at a very early age.

Exactly fifty years have passed since a president of the British Association last warned his audience of the danger of famine. Sir William Crookes was then alarmed at the prospective shortage of wheat. He produced evidence to support his conviction that England and all civilized nations stood "in deadly peril of not having enough to eat". But he qualified his gloomy forebodings by the statement that the chemist must come to the rescue of the threatened communities, and went on to discuss the possibility of the fixation of atmospheric nitrogen. If that were achieved, the future, said Crookes, could take care of itself, and "in days to come when the demand may again overtake supply, we may safely leave our successors to grapple with the stupendous food problem". The chemist did come to the rescue, and the plant breeder too, though not quite in the way that Crookes imagined; and now the day has came when we must grapple again with the problem. We must not encourage the easy thought that some entirely new development in science will solve it quickly; there is nothing in sight comparable with the importance of synthetic fertilizers. There are certainly some interesting investigations in progress, for example, the production of food yeasts from molasses, and of fats by the action of micro-organisms on carbohydrates. All that can reasonably be said about these new developments at present is that they show the need for fundamental research in an almost untouched field. They are very unlikely to lead to a new and substantial source of supply of food within the next thirty years. So far as Great Britain is concerned, we must plan our economy on the assumption that food will be both scarce and dear for many years to come. Its scarcity is obvious to us; its dearness is concealed by a policy of subsidies. I do not criticize the policy. I refer to it only because it tends to hide a state of affairs that should be realized by every thinking man.

One or two years of good harvests in the wheat-producing countries may go far to relieve the present troubles of Europe, and will be of great benefit to us. But the supply of wheat is only part of a larger problem. World food supply will only keep up with demand if the productivity of land is increased, and more land is brought into cultivation. The productivity of land in the United Kingdom is already high; much higher, for example, than in most European countries and in North America. The productivity of labour on the land has increased in recent years much more than the productivity of labour in any other old industry. One man working on the land now produces enough food for twenty-five of the population. New Zealand surpasses all other countries in both respects. It is a land blessed by Nature and improved by science. But few people realize that in our small country we now grow enough food for twice the population of Canada. There is still room for a great advance. There is a consensus of opinion among experts whom I have consulted that the production of food in the United Kingdom could be raised by 20 per cent within five years by a combination of measures, such as the improvement of grasslands, the conservation of grass for winter feeding, the control of pests and weeds, the extended use of fertilizers, and the development of large tracts of marginal land such as exist in the Highlands of Scotland. It is argued that, though this would need considerable capital expenditure, there is no direction in which capital expenditure would yield more certain dividends to the nation, or make a more substantial contribution to the balance of trade.

I find these views convincing. But even if all this were to come to pass, we shall still need to import food for twenty to twenty-five million people unless there is to be a large outward movement of population; and we must not lose sight of the fact that at least twenty million people are added to the population of the world every year, and that it is conceivable that in another seventy years, or even less, the world population will have doubled. Whatever other countries may do, it is our bounden duty, and the only certain way of safeguarding our future so long as we remain a large food-importing country, to develop our colonial territories, particularly the underpopulated African colonies, where the increase in population that would follow the control of disease and the increase of food supply would open fresh markets for international trade. This great task will call for the intensive application of science, in collaboration with other countries. The tale of plant disease in our Colonies, for example, is a sorry one. I shall predict that unless the prevention of disease among plants and animals, and all other scientific problems of the supply of food, are studied on the same kind of scale, by men of similar calibre, as are the problems of human health, chaos and misery will result. Whatever new comforts and luxuries may be provided in future by the advance of physical science, it is on the development of the biological sciences that the peace and prosperity of the world will largely depend. Until recently there have been far too few careers open to young biologists outside the field of the medical sciences. There has been nothing corresponding to the Colonial Service, which has offered to young administrators a life of adventure nicely seasoned with economic security. All members of the British Association will therefore welcome the intention of the Government to inaugurate a Colonial Scientific Service, and will hope that the conditions of service will be such as to attract young men of the highest quality.

Challenge of the Times

We live, indeed, in difficult times. But they are very interesting times; and difficulties are bracing to a nation which has not lost the resilience of youth. We must not get into the way of thinking of our great country as an elderly man who is told by his doctor that if he is very careful of his diet, and avoids all exertion and worry, he may look forward to some years of placid life before he dies. This is a time for adventure; for taking risks. Calculated risks, of course; but not so nicely or so lengthily calculated that they are taken too late. My contacts with universities and with industry are not now so frequent or so close as I should like them to be; but they are enough to convince me that the spirit of adventure in science is as lively as it ever was. It is that spirit which will largely determine the future. Many years hence, when a president of the British Association reviews the progress of the nation from the depths of bankruptcy to new and unsurpassed heights of prosperity and influence, he may well have occasion to refer, as I did at the beginning of this address, to the great influence of the work of a few young men who are now unknown to the public; and he may justly claim that the chief cause of the change was that we had found the right way to combine originality in science with enterprise and speed in its application.

SUMMARIES OF ADDRESSES OF PRESIDENTS OF SECTIONS

RECENT ADVANCES IN THE STUDY OF THE CRYSTALLINE STATE

IN his presidential address to Section A (Mathematics and Physics), Sir Lawrence Bragg points out that X-ray analysis of crystals may be said to have attained its majority this year. Its importance has been recognized by the formation of an International Union of Crystallography, and it takes its place with the other branches of science which have unions of their own. Laue discovered the diffraction of X-rays by crystals in 1911; now most universities have an active centre devoted to the investigation of the arrangement of atoms in matter by means of X-ray diffraction. Sir Lawrence has worked in this field from the beginning, and takes the opportunity which this address affords to review what has been accomplished in little more than a generation. X-ray analysis is a typical border-line subject. Its successes are interesting to the chemist, mineralogist, metallurgist and biologist as well as to the physicist, and this is perhaps its most attractive feature.

In X-ray analysis in general, we are seeking to interpret the manner in which a substance diffracts X-rays owing to the spatial arrangement of its atoms. Two main lines of work may be distinguished. On one hand, there is the analysis of the pattern of the perfect crystal, where the atoms have taken up positions of equilibrium under the influence of the interatomic forces; from the conformation of the structure we can gain a deep insight into the nature of these forces. This study is principally of interest to the chemist, because it presents him with a scale plan of the chemical molecule and of the way molecules or ions are held together by the intermolecular forces to form a solid structure. The results of X-ray analysis have had a profound influence on chemistry and mineralogy and solved many problems. A steady advance has been made in tackling more and more complex molecules, and a stage has already been reached where such compounds as the sugars, strychnine, sterols and penicillin can be analysed, to take a few examples. We would like to pass on to the study of such high complexes as the molecules which form part of living matter—nucleic acids, proteins and others.

The other side of X-ray analysis is concerned with what we might call the 'geography' of atomic arrangement in matter. The perfect crystal is an ideal which is rarely attained. Even if the substance is pure it is composed of a mass of crystals, and we are interested in the size and shape of the crystallites and their growth, in allotropic change, and in their preferred orientation and state of strain after mechanical treatment; if complex, we are interested in the fitting together of the crystallites of different kinds. Metastable structures often exist in which there is partial separation into regions of different composition, while a continuous crystal lattice is preserved though in a distorted form, as in the permanent magnet alloys, in martensite, or in age-hardening alloys. We can study the distortion of the lattice by the thermal waves at high temperatures. Amorphous and semi-crystalline matter can be examined. All these aspects of structure are of prime interest to the physicist and metallurgist. They are vitally interesting to the technologist, because the geography of the structure has a profound influence upon its mechanical, electrical and magnetic properties.

In this address, Sir Lawrence reviews the active centres carrying out X-ray investigations in Great Britain; examples are given of recent work, presenting a picture of what has already been achieved, and indicating the lines of exploration which are now being pursued.

SPECIALIZATION AND CULTURE IN CHEMISTRY

PROF. JOHN READ, president of Section B (Chemistry), deals with some of the problems of increasing specialization in chemistry. The growing burden of new knowledge in chemistry, as in science generally, has created many new problems for the student, teacher and research worker. These problems are largely bound up with the growth of specialization. A fundamental problem confronting the chemist is that of acquiring a proper education leading to a cultured outlook and fitting him to take his place in the world of men and affairs. What steps can be taken to combat the narrowing outlook which threatens to affect science students at all levels, and to provide for their social, cultural and spiritual needs ?

Formerly a chemistry student was trained to become an all-round practitioner of his art; but latterly the vision of the student and research worker has narrowed. We have entered into an age of team-work. Chemical science has been aided nobly by such work; but the individual worker is liable to sacrifice a great deal in the process.

The mental effect of an unrelieved absorption in a specialized field of science has been vividly described by Charles Darwin, and the growth of such specialization in later times has led to many criticisms of its effect upon the human subject.

It is in the schools that we view the education of the incipient scientific worker in its broadest aspect; and it is here, helped in the ideal case by home influences, that the foundations of the necessary wider interests must be firmly laid. There ought to be no sense of antagonism between arts and science, and any form of modern education should be made up of a proper blend of each. A lively interest in literature, history, art, music or the drama, gained in early life and nurtured thereafter, would do much to solve some of the problems of specialization in science. Highly specialized teaching in science ought to be avoided in the schools.

In the universities, the way of teaching chemistry is of the first importance. Although his chemical studies must deepen rather than broaden as the student passes onwards towards research, he should always be encouraged to realize that there are a chemical geography and a chemical history, and that these offer him avenues leading to a wider horizon. Chemistry itself may become a cultural and humanistic instrument of high value. Historical chemistry is linked in turn with philosophy, literature, art, and even with music. During the student's undergraduate days a great deal could be done to arm him against the dangers of specialization, and more importance should be attached to the technique of teaching from this point of view.

During postgraduate research work the student should be encouraged to undertake a certain amount of teaching work in the junior laboratories. He should also use opportunities to migrate to new research centres either at home or abroad. A research theme of a suitable kind ought to help the student to become resourceful and to develop originality of thought, besides stimulating his imaginative and critical powers; unfortunately, research themes often fail to fulfil these requirements. Finally, the proper education and training of the young scientific worker, with the application of the various influences that have been mentioned, including personal contact with his teachers, call for the provision of adequate staff and accommodation.

GEOLOGY TO-DAY AND TO-MORROW

THE theme of Dr. A. E. Trueman's presidential address to Section C (Geology) is the future of geology. At the present time, he points out, geology is passing through a period of very active growth. It is doubtful if at any time since the 'heroic age' of the science, a hundred and fifty years ago, there has been so rapid an increase in our knowledge of earth history. More geologists are professionally employed in all parts of the world; many more fields of human activity are dependent on the success of their operations than ever before. They search for ores, coal, oil and water. If in the future we are to depend on atomic energy for some of our power, it will need geologists to locate the new materials. Inevitably, we shall be driven to exploit mineral resources occurring at greater depths, or of poorer quality; while we continue to use materials from the earth's crust the geologist will have an increasing part to play in their discovery. In the course of these explorations much new information is being gathered, but many major problems still await solution.

Although geology is in this phase of active development, its results and methods are probably less familiar to the educated public in Britain than those of any of the other fundamental sciences. This widespread unawareness of geology, which is not found in most other countries, is in marked contrast with the position of fifty to a hundred years ago and calls for serious attention, for it cannot be held that any science is in a healthy condition if its work is insufficiently understood by laymen. The absence of almost any geology teaching in schools and the scarcity of teachers with any acquaintance with the subject are partly responsible for present conditions. It is claimed that geology should form part of a wide cultural education; it can serve as a link between science and more humane studies or as a basis for a new type of synthesis.

Fortunately, the comparative lack of public interest in geology has not in recent years limited the recognition of its value by Government. Much has happened to stimulate the demand for geological advice for a variety of economic purposes, both in Britain and overseas. In the limited area of Great Britain, the Geological Survey, founded more than a hundred years ago, not only meets new demands for more detailed maps but also is required to undertake great new responsibilities. The record of its work in war years, recently published, exemplifies the wide range of activities in which geological information is necessary; in view of the growing importance of the work of the Survey, the need for an expansion of its numbers has been recognized. The Colonial surveys, even more in need of increased support, are accepted as having a vital part in the economic development of the Colonial territories. The present Secretary of State for the Colonies has himself on several occasions appealed to young men to take up the work of geologists in these areas. The small surveys of the past have been sparsely staffed, one geologist being responsible for thirty times the area for which a member of the home survey was responsible. In the past, several Colonial geological surveys have paid for their own cost many times over by discoveries of diamonds and ores, but future results must not be judged only in terms of exportable minerals; more bulky materials, such as limestones, clays, road materials and especially water, may contribute even more to the development of the territories. Alongside these developments of geological survey activity throughout the Commonwealth, the promotion of researches by unofficial geologists is equally essential.

In the immediate future we must expect an increasing tendency to specialization in limited fields and particularly on the fringes of the subject, as on the borderlines between geology and physics, or geology and chemistry. Advances in such fields as geophysics call for workers with more extensive training in the two subjects. The co-operation of geophysicist and geologist makes possible the interpretation of concealed structures: England south from the Wash requires special study in view of the possibilities of new coalfields. But on a wider front we may expect to learn more of submarine areas, of the structure and origin of mountains and of the larger features of the earth. Work in geochemistry, in the distribution of minerals, the origin of rocks and the nature of clays, promises rapid development. In the fields of geomorphology the problems are barely touched; in palæontology the existing data only serve to illustrate the extent of the problems to be solved. But in all these extensions of knowledge it may be hoped that it will be possible to avoid the isolation of the fields of study, relating them all to stratigraphy and the study of the structure of the earth's crust which form the 'heart of geology'.

TEACHING ZOOLOGY IN THE UNIVERSITY

PROF. H. GRAHAM CANNON discusses "Undergraduate Zoology" in his presidential address to Section D (Zoology). After the First World War, he says, the interest in zoology became almost exclusively experimental. The more orthodox attitude of comparative anatomy became the one to be avoided. This was due to a variety of reasons, but largely because, for generations, zoologists had been teaching the comparative anatomy of dead animals without worrying about how these animals lived. As a result of this changed outlook between the two World Wars, a generation of teachers has grown up who are predominantly experimentalists, and our present undergraduates run the risk of becoming very knowledgeable about the latest developments of experimental technique while knowing very little indeed about the anatomy of the animals on which they work. Recently, but somewhat tardily, it has become recognized that there is such an aspect of zoology as functional morphology, that is, a method of treatment where structures are dealt with not merely in the way in which they are built, but also, and at the same time, from the way in which they function. It is this attitude which should form the basis of undergraduate zoology.

Two main difficulties present themselves in considering the teaching of zoology to undergraduates. First, there is the modern tendency to scorn any elementary teaching and to thrust the first year's university work back on to the schools. This misguided attitude may be excusable in the more basic physical sciences and mathematics; but in the biological sciences, which, after all, utilize the physical sciences as their tools, it is completely illogical. Moreover, it is essential that the more experienced teachers, preferably the professor, should always deal with this fundamental first year's introduction to university study.

Secondly, there is the tendency almost everywhere to introduce specialist courses into the undergraduate years: a tendency which is being encouraged by the efforts of the University Grants Committee to foster the establishment of readerships or even chairs in the most abstruse specialist aspects of biology. At the undergraduate stage the students are quite unable to assimilate such courses. The sort of courses which are being established are those admirably suited for the second part of the Cambridge Tripos. But what is almost invariably overlooked is that the second part is entirely a postgraduate course. The honours degree is given on the first part of the Tripos, and this corresponds to the degrees in the 'Redbrick Universities' of honours general science. It is suggested that it would be a great advantage in all 'Redbrick Universities' to abolish the specialist honours degree altogether and insist on a first degree being taken in general science as at Cambridge. The more specialist attitude to the subject could then be left to a postgraduate year, leading preferably to a master's degree.

SOCIAL GEOGRAPHY

IN his presidential address to Section E (Geography), Lord Rennell of Rodd deals with the geographical environment of man as a social animal, and consequently does not attempt to consider the geographical circumstances of the origin of human species or prehistoric man. But the spiritual as well as the material consequences of geography on human society are considered rather by posing a series of questions, and stating a number of problems, especially in connexion with Africa, than by proposing conclusions or solutions.

Starting from the influence of geography on the spiritual as well as on the material development of society, Lord Rennell makes a strong plea, which he takes up again at the end of the address, for the teaching of geography in medium and higher education as a means of creating a bridge between the humanities and the natural sciences, which "except among the leaders of the latter group" have more and more tended to develop on independent lines divorced from each other. This tendency he dates from the decline in classical education; but he sees in geography, and especially in social geography, a new link which could be made between the two, in view of the manifold contacts which geography has with both the exact and the abstract realms of human thought.

From this point he goes on to discuss a number of problems arising in Africa. What are the reasons why Islam spread as far as the southern rim of the North African deserts but never affected the population south of the northern fringe of the forest belt? Why was the negro and negroid population of Africa antagonistic to outside civilization in spite of many opportunities of contact with more civilized people from Greek and Carthaginian times through all the period of Arab and Portuguese navigation until the European conquest? Why then, and only then, did a ferment of Western civilization begin, within say the last seventy years? Yet the civilizing influence of the Mediterranean found no difficulty in crossing the Sahara and following up the Niles until they came to a dead end against the unwillingness of the negro to adopt or adapt. Why is there no trace of writing or even ideography in Dark Africa? Why was there no true architecture, the wheel or the plough in Africa south of the deserts until the conquering European started the modern phase?

Lord Rennell goes on to discuss the anomalous and absurd consequences of the European conquest, the purpose of which, in spite of Lord Hailey's investigations, remains very obscure. He refers to the ribbon development of colonies along the coastal routes, and the strange efforts of our Colonial Office to keep separate, contiguous British territories in eastern Africa, in spite of departing substantially in recent years from the dual mandate principle in favour of "colonies d'exploitation". He concludes with the suggestion that only the geographer with a foot in each of the camps tenanted by the humanist and the natural scientist, is fitted to seek answers to the problems he raises, and is unbiased enough to propose solutions which it is incumbent on European nations generally, and ourselves in particular, to find, in order "for the sake of our own good name" to remedy the administrative and social chaos which is Africa.

THE PRICE SYSTEM

In his presidential address to Section F (Economics), Sir Hubert Henderson remarks that the idea of a return to the price system which is widely advocated to-day is marked by the same defects that marred the idea of economic planning which was so popular a year or two ago, namely, incoherence and wishful thinking.

In its most general sense, the price system is an inevitable outcome of the use of money. So long as goods and services are bought and sold for money, there must be prices; and these prices must always exert a powerful and pervasive influence. It is important, therefore, that this influence should be a healthy one, that the configuration of prices should be such as to pull in directions which accord with the public interest. We want price relations that are right, so far as that object is attainable. But we must be careful not to beg a major question. In the matter of price relations, as in many others, it is easier to be sure that certain things are wrong than to know at all precisely what is right.

According to current price system ideology, the right price is the theoretical equilibrium price. In times of large-scale economic maladjustments, however, this concept is ambiguous. The theory of value comprises two parts, short-term and long-term, each with its appropriate equilibrium price. These prices are seldom far apart in ordinary times, when the economic system has not been subjected to any recent large disturbance. But they are apt to diverge widely when the maladjustments to be corrected are very large. It is a mistake to suppose that in such conditions the theoretical short-term equilibrium price is either what we want, or what we normally get in a free economy. There are apt to be serious and injurious anomalies in price relations when shortages are widespread.

Shortages, or surpluses, are, of course, most widespread, and the consequential anomalies most serious, when there is a large maladjustment between aggregate demand and aggregate supply. It is therefore especially important to avoid disequilibrium here. In Great Britain at the present time it is rightly a main object of policy to remove the inflationary trend in our economy. Success in this might enable us to dispense with many of the controls that irk us to-day, and to simplify others. But it would not enable us to remove them all. The regulation of long-term capital expenditure would still be desirable for a fairly considerable time, and the regulation of imports indispensable for a much longer time.

If the consuming public were free to choose, there is no reason for supposing that imported goods would represent a smaller fraction of their total purchases than before the War. Since our total rate of consumption is at about the pre-war level, this would imply imports at about the pre-war level; or an increase of more than one quarter in our present import-bill. The removal of every vestige of inflation in our internal economy, though helpful, could not radically alter this result. With a huge deficit in our current balance of payments, we are in no position to contemplate a largely increased expenditure on imports.

Price system ideologues believe that disequilibria in the balance of payments can always be corrected by variations in foreign exchange-rates. This belief is attributable to the pivotal role which they assign to the concept of equilibrium price. When, however, our import–export balance is so far from adjustment, there is a huge divergence between the short-term equilibrium rates of exchange and the long-term norm represented by purchasing-power parity. It might be disastrous to try to make our actual exchange-rates approximate to the former. It is better to keep them in the neighbourhood of purchasing-power parity; and to recognize that it will remain essential to regulate the volume of our import purchases as effectively as we now do by means of import restrictions.

More generally, the time-honoured theory of value endorses, and indeed enjoins, the humdrum practical proposition that, when large adjustments have to be made, regulation and deliberate direction may be useful or even indispensable.

THE YOUNG ENGINEER

In the presidential address to Section G (Engineering), Wing-Commander T. R. Cave-Browne-Cave deals with the qualifications and personal qualities necessary in 'the young engineer', and treats the problem of engineering education from an unusual point of view because his experience has been in the application of engineering science to a wide variety of new developments, mainly in connexion with airships and aircraft engines. Since going to University College, Southampton, he has been dealing not only with students preparing for the external degree of the University of London, but also with apprentices following part-time courses for national certificates and still more practical qualifications. The review is based upon the knowledge and personal qualities which a young engineer should have acquired shortly after the end of his formal training, say at the age of twenty-eight to thirty, and may serve as a guide to those who are considering engineering as a career. It may also be taken as a background against which the various stages of engineering education are examined.

Mathematics is a limiting factor in the progress of a student along the main road of engineering science. It must, therefore, be of a really appropriate type and no harder than is necessary for each corresponding stage.

The general structure of engineering education should be revised so that it is possible for candidates to enter at any appropriate stage. Changes from one course to a more suitable one should be simpler than at present, and there must be fewer 'casualties' who fall out and go no further. Courses of instruction should be aimed, not at a final examination, but at the future useful application of the knowledge acquired.

The student must develop the art of learning by himself from books, because he will have to acquire in this way a great deal more science and technology than can be included in his formal training. If this is achieved, the present overcrowded syllabuses can be shortened by leaving certain parts for subsequent study when required.

Attention is directed to the importance of developing skill in clear explanation of technical matters, both in verbal discussion and in writing. The effective value of a proposal depends not only upon its technical merit but also upon the clarity with which it is communicated.

It is suggested that national service for students who are to read for a degree should be taken between the intermediate examination and Part I of the final degree examination, and that the fighting services should arrange this year to give, in addition to military training, a good practical groundwork similar to that given in the first year of service technical training. The year of national service would then be a valuable addition to the degree course as well as a foundation for future war service, if required.

Personal qualities, judgment, effectiveness, enterprise and determination are so important that they must be considered in the selection of a candidate and must be developed throughout his training.

The address is intended to open a general discussion on engineering education, relating it definitely to the knowledge and qualities which experience shows to be desirable in later engineering work. It contains much new and possibly contentious matter, which, with the discussion on it, should form a useful contribution to the developments which now have to be made in engineering education at all levels.

INVESTIGATION OF FOLK-LIFE IN BRITAIN AND ABROAD

MR. R. U. SAYCE discusses folk-life in his presidential address to Section H (Anthropology). Until about 1914, Britain occupied a well-recognized place in the front rank of folk studies; but since that time it has been falling further and further behind, and appears to a great extent to have lost touch with the developments that have taken place in European countries. A few scholars continue to produce work of distinction; but they lack a common meeting ground, where adequate discussion can stimulate thought and help them to see their special problems in relation to the whole. There are even societies devoted to dialects and place-names, beliefs and customs, dance and song, which have scarcely any contact with one another, although they are all concerned with the culture of the folk. In spite of this fragmentation, we are realizing, as general ethnologists have already done, that a culture must be studied as a whole. This, of course, makes our studies more complex, but also far more interesting. It also needs special training; the student of folk-life must know something of the methods of, and the results achieved by, archæology, history, psychology, anthropology, to say nothing about architecture, agriculture, technology, etc. There can be little doubt that the present unsatisfactory state of British studies in this field is due largely to the failure of the universities to provide the necessary training.

Folk-culture is very closely related to ethnology and to history, and could only neglect one of these indispensable allies at great loss to itself. For many years it has enjoyed close contact with ethnology, to which it is greatly indebted; but it has neglected its second essential partner, so much so that it has been in danger of becoming an unimportant appendage of the former. Nevertheless, a very slight knowledge of our problems is sufficient to make it clear that their solution depends on a historical approach. The subject does not consist of an inert mass of survivals from a vague and generalized past. The contents and their vitality change. Sometimes customs and beliefs appear to survive only in remote circles or among the least educated, and these periods may be succeeded by others when irrational ideas spread rapidly and become widely current. We can see fluctuations of this kind in western European civilization as well as in that of ancient Greece.

The impression must not be given that folk-culture deals only with 'primitive thought' and superstition; it includes the whole way of life of the people—their houses, clothes, food, work, and recreations. All these change, sometimes abruptly, at other times almost imperceptibly; old elements drop out, and new ones come in. For a knowledge of the changes we have to turn to a much closer co-operation with historians and archæologists.

At the present time, certain long-established interpretations of European folk customs are being challenged. A new school of folklorists questions whether the old harvest customs, for example, had any connexion with beliefs in vegetation spirits, and suggests that scholars like Maunhardt and Frazer made insufficient allowance for the spirit of jollity and of competition that would be quite natural where young men and women are for the time working together in the fields. The new school recommends a more modern, functional approach to the problems. There is very much of interest in their arguments, but the question is essentially a historical one. What did the medieval peasant think about the powers that influenced growth and fertility? Did he hold animistic beliefs, or was the hare that dashed out of the last standing corn nothing more than a hare? Until we can answer such questions, it would be as dangerous to apply ideas derived from studies of harvesters during the last century or two to their forerunners of a thousand or two thousand years ago as it would be to accept a modern educated African as a guide to the conceptions and emotions that underlie the age-old tribal customs.

In conclusion, Mr. Sayce makes a strong appeal for properly trained workers in Britain, and for the fullest possible intercourse with scholars in those countries where studies of folk-life have made so much more progress in recent years than they have done in Great Britain.

RECENT ADVANCES IN COLOUR VISION

IN his presidential address to Section I (Physiology), Prof. H. Hartridge discusses recent views on the mechanism of colour vision. Colour vision to-day, he says, is in a situation not very different from that of nutrition half a century ago. The solid constituents of the diet—the proteins, the fats and the carbohydrates—were well known and understood. All major problems concerning them had been solved and there was really little more to be found out about them. Then suddenly the importance of the accessory food factors, the vitamins, began to be disclosed. Substances, small in amount, became of prime importance in dietetics, and we know to-day how much our health and well-being depend on these accessory food substances.

Atomic physics might be taken as a second example of a branch of science where not many years ago all problems appeared to have been solved and everything to be known. We have only to look back at the last thirty years to realize how very limited our outlook really was in those days.

Human colour perception to-day is in a similar situation, because, until quite recently, most—if not all—known visual phenomena were adequately accounted for either on the three-colour theory of Thomas Young or on the four-colour theory of Ewald Hering. But we are beginning to suspect that things are not quite so simple as they seemed and that there may be present in the human retina certain accessory receptor mechanisms, not embraced by either of these theories, which, however, play an important part in man's colour sense. The questions which now confront us are similar to those which claimed the attention of the early workers on the vitamins.

So far as present evidence goes, there appear to be four additional types of receptor, three of which have a single maximum of activity in the spectrum, which is situated in the yellow, in the blue-green or in the blue. The fourth has two regions of activity: in the extreme red and in the extreme violet; and for this reason may be referred to as 'the crimson receptor' mechanism. These four accessory mechanisms, which play a relatively unimportant part in foveal vision at medium visual angles and at medium light intensities, hold a very different position when these conditions are departed from. Thus in the dichromatic zone of the retinal periphery, at medium light intensities and at the fovea at very high intensities, two of these subsidiary receptor systems, the yellow and the blue, hold a predominant position. On the other hand, at very low light intensities and at very small visual angles, the two receptor types which are most strongly represented are the crimson and the blue-green.

While nearly every phase of human colour perception, when closely examined, discloses evidence of the presence of these supplementary receptors, the idea that there are four of them, or that they have the properties preliminarily assigned to them, may have to be modified in important respects as additional knowledge is acquired.

Lessons of a valuable kind are to be learned from a study of the history of the vitamins; because, whereas only a few years ago a few appeared to suffice, we now have overwhelming evidence that there are many. So it may be with the visual receptors. At this juncture the important point is for us to recognize that accessory receptors are present in the human retina, and then to concentrate attention on the wider problems which their presence involves.

PRESENT-DAY TRENDS IN BRITISH PSYCHOLOGY

PROF. REX KNIGHT, in his presidential address to Section J, remarks that more than sixty years have now passed since the "Encyclopædia Britannica" first published in 1886 Ward's famous article on "Psychology", which William James at once described as "marking the transition of British psychology from one epoch to another". Ward's article showed that psychology was no longer to be regarded as a branch of analytic or speculative philosophy, but as a positive science concerned with the systematic investigation of matters of fact. Since it appeared, striking changes have occurred in the scope, methods and practical usefulness of psychology in Great Britain.

In scope, there have been five major developments. First, physiological psychology, which everyone except Bain neglected in the 'eighties, has come into its own. This has been due to the advocacy of Sully and James, the general acceptance of the evolutionary theory, the researches of neurologists like Lashley and Sherrington, and the influence of the behaviourists.

Secondly, psychology is no longer preoccupied with cognition. The work of James, McDougall and Freud has developed an intense interest in dynamic psychology, and at least as much attention is now given to the conscious and unconscious motives that underlie thought and behaviour as to the processes which are involved in the acquisition of knowledge itself.

Thirdly, sixty years ago psychologists concerned themselves mainly with human beings, and with human beings who were adult, civilized and normal. Now animal psychology, child psychology, anthropological psychology and abnormal psychology are all prominent features of the psychological landscape, and are receiving much attention.

Fourthly, psychology was generally regarded in 1886 as the study of man as an isolated individual, whereas present-day psychology is much concerned with man as a member of society.

Fifthly, the last sixty years have seen the development of mental tests, which, though originated by Galton before Ward's article appeared in the "Encyclopædia Britannica", have been developed during the present century in Britain chiefly by Spearman, Thomson and Burt.

In method, there have also been five notable changes. First, introspection, which dominated the field in 1886, has been supplemented by observation of behaviour and exploration of the unconscious. Secondly, experimental psychology, which was disparaged by most nineteenth-century British psychologists, has established itself. Thirdly, the anecdotal method, once so common in psychology as well as biology, is under sentence of banishment. Fourthly, field-studies have become as important as laboratory investigations. Fifthly, the statistical principles and techniques appropriate to psychological data have received great attention.

In practical usefulness, psychology in Britain has moved during the period under review from a stage where applied psychology was almost unknown to one where psychology is constantly being applied to the practical problems of public and private life. Educational psychology is now an important ingredient in the training of teachers, and educational psychologists are becoming established members of the staffs of education authorities. Psychiatry is a recognized branch of medicine, and clinical psychologists are employed in many fields. Occupational or industrial psychology, the development of which in Great Britain owed so much to Charles Myers, was used on a large scale in the Second World War, and is now being used in the drive for greater productivity.

STUDY OF THE BRITISH FLORA

IN his presidential address to Section K, Prof. J. R. Matthews begins by referring to some of the more noteworthy landmarks in the history of British botany. The exact recording of native plants, an essential preliminary to the formulation of any scientific account of them, dates from the time of William Turner. Although new records have continued to be made down to the present time, the discovery and discrimination of more than a thousand species of vascular plants before the death of John Ray in 1705 remains an outstanding tribute to the work of the early explorers. Much of the subsequent floristic work was carried out by botanists who made no claim to be called professional, and it often found expression in the publication of local or county floras. The value of these surveys could not be seriously doubted, and there is a growing need for their encouragement and support by all responsible authorities, public or private, who have the desire to see a revival of interest in the scientific study of local natural history.

The edifice of British botany raised by the early naturalists gradually became expanded and enlarged, and by the end of the nineteenth century, knowledge of the composition of the native flora was relatively complete. The distribution of plants had also attracted considerable attention, and Great Britain had become one of the best botanically explored countries in the world. But along with other subjects, botany shared in the general scientific renaissance which occurred in the early years of the twentieth century. Although the systematic study and recording of plants continued, greater emphasis began to be laid on the ecological approach to field studies. The investigation of heredity and the study of variation by the experimental method and the advance of cytology were at once recognized as sources of valuable data contributing towards an understanding of the species problem, which had followed the enunciation of the Darwinian theory of evolution. Detailed ecological studies of individual species throughout the range of distribution were necessary, if the responses to changing environmental conditions were to be correctly interpreted. Such investigations were closely connected with problems of taxonomy, since it was evident that much intraspecific variation was related to environmental gradients. It should therefore become the purpose of experimental taxonomy to examine and analyse the heterogeneous nature of the species complex and correlate the results of such analysis with those derived from physiological and ecological studies. Investigations along these lines would prove of immense value in the application of scientific botany to the practice of horticulture, agriculture and forestry.

THE SCHOOL IN A PROGRESSIVE SOCIETY

IN his presidential address to Section L (Education), Mr. W. O. Lester Smith points out that school business has increased rapidly in recent years, affecting each of the leading partners in educational administration—the Ministry of Education, the local authority, the head teacher and his colleagues. It is worth considering how this has come about, and there would seem to be three main causes: social change, the widening scope of education, and the modern emphasis on management. The administrative pressure on the head teacher is more serious in its consequences than that on the other two partners, because hitherto in Great Britain we have regarded the school as the natural growing point of educational thought and technique, and we owe much to the creative wisdom of some of our great head teachers.

It is usual to attribute the increase of administration to the growing demands of Government departments; but this is a partial diagnosis, for the preoccupation of the head teacher with managerial detail began not in the schools associated with the State but in the independent public schools from the days of Thring onwards. It was due largely to the emphasis in these schools on an active corporate life and on giving each pupil a full or 'total' education. In a sense, therefore, the criticized Rugby appointment of an administrator as head master was but a logical recognition of a process that has been unfolding itself for a century.

The head teachers of the primary and secondary schools associated with the State in Britain are now being diverted from their educational task by a growing administrative pressure, and this is particularly unfortunate because the abolition of the elementary school by the Butler Act was a historic opportunity, and the heads of the schools emerging from the elementary tradition ought to be free to concentrate on the difficult task of making education a living force in the social democracy now taking shape. Just when imaginative leadership is urgently necessary, the head teacher's function is becoming increasingly managerial as a result of the growth of corporate activities, the demands of society, and the aftermath of Government schemes and schemes launched by well-meaning importunate organisations.

Some of the new demands are necessary and desirable, but others are hard to justify. There is also an increasing use of schools for extraneous purposes, involving the necessity of putting away daily all equipment and appurtenances of educational or æsthetic value. We cannot hope to achieve quality unless we are prepared to put education first; and it is regrettable that, owing to shortages of staff and buildings, we make a habit of measuring progress in quantitative terms. The schools of the people were for centuries retarded by what Defoe called the law of subordination, and to-day Demos is apt to treat his schools like the old feudalism writ large.

One of the most difficult issues is to determine the extent to which schools should respond to the many claims which society makes upon them. There is general agreement that they cannot to-day thrive in isolation, or, as the McNair Report puts it, teachers cannot be "a race apart". On the other hand, there is a limit to sociability, a plimsoll line at which service to the community becomes a danger to education. If a service rendered by a school fits naturally into the curriculum or the corporate life, it may provide useful educative experience; but if there is a marriage of convenience designed primarily to further an extraneous scheme, there can be serious waste of teacher- and pupil-time without compensating advantage. We ought, as a nation, to recognize before it is too late that the essential function of each school is to educate, and that of each head teacher to give expert guidance to his team in the conduct of an extremely difficult operation, requiring human sympathy and a sure grasp of the intricate problems of childhood and adolescence.

AGRICULTURE AND THE WORLD FOOD PROBLEM

In his presidential address to Section M (Agriculture), Dr. G. Scott Robertson compares the present world food problem with that in 1798 when Malthus put forward his theory that populations tend to outrun their means of subsistence. The invention of machinery, the discovery of artificial fertilizers, the development of transport and colonization for a time made his views seem unduly pessimistic and out of date, but two world wars have brought up afresh the problem of attempting to provide adequate food for the peoples of the world.

The two chief factors responsible for the present situation are the rapid increase in the world's population (estimated at 20 million per annum) and the improved standard of living of that population. Fortunately, the prospects of finding a solution are more hopeful to-day than they were a hundred and fifty years ago, when hand labour and primitive tools set a limit to agricultural production, for by merely applying existing knowledge and making a fuller use of available resources, the world output could be doubled or trebled in a relatively short time. The Food and Agriculture Organisation is doing valuable work in pointing the way by which this can be done, and the only permanent solution seems to be in increasing production in each country. The requirements of India and China, for example, are so vast that outside help would be inadequate even if it could be provided and the immense transport difficulties overcome.

Aid from the more advanced countries can best be given by helping the less developed ones to modernize their agriculture so that they can feed their own peoples. To do this, very large quantities of fertilizers will be required, and fertilizer manufacture must form a part of their industrialization. Even in Europe and America, much could be done to improve output. More attention to the growing and conservation of grass, for example, would increase milk and meat production and at the same time reduce the competition with the human population for cereals. Enormous economies in grain crops could also be achieved if the ravages of pests during storage were prevented; the knowledge exists and only the practical application of it is needed. The Council of the Food and Agriculture Organisation has already taken this matter up and recommended member countries to take immediate and concerted action in such matters.

Losses in the animal world from disease are estimated as even more serious than in the case of crops, and the necessity for preventing this wastage becomes the more vital as the standard of living rises not only in advanced countries but also in the more primitive.

Improved nutritional standards will inevitably mean changes, for agricultural produce will have to play a more important part in world trade than in the past, and the old conception of exchanging agricultural for industrial products gradually give place to an interchange of agricultural products. Restrictions, such as tariffs and quotas, will have to disappear, for no country should be forced into a form of agriculture unsuited to its soil and climatic conditions. The peoples of the world, in fact, will not be properly fed or any real prosperity achieved until there is both a greatly increased output and the fullest interchange of the products of agriculture on a worldwide scale.

THE CORRESPONDING SOCIETIES AND THE COMMUNITY

The president of the Conference of Delegates of Corresponding Societies, Prof. H. J. Fleure, deals in his address with the relationship between the corresponding societies and the community. Many such societies belong to and have opportunities to serve our cities and counties in the important and necessary effort to re-emphasize social life, which has been submerged by the crowds that have taken the place of traditional groups, crowds made up of atomized individuals. Rousseau, Hobbes and others have too often spoken as though human society were made by the coming-together of individuals, whereas it is in society, itself basically a heritage from pre-human phases, that human individuality has struggled towards expression. The group again and again has sought order through imposed uniformity ; the individual has, increasingly, rebelled and has immensely extended men's vision. We need only read anything written about man and the universe before Copernicus, Bruno, Galileo, Newton and Darwin to realize the importance of the newer ideal "We seek the truth" ; imposed uniformity may prevail for a short time, but it must fade ; it closes the mind.

In the late eighteenth century steam-power and mass-production set society sailing on an uncharted sea and found it philosophers to justify or excuse exploitation under the theory of *laisser-faire*. The atomization of the individual, the submergence of society in the crowd, have been widespread with unfortunate consequences. The corresponding societies and the British Association, both pledged to the search for truth, can help one another and our communities towards rehabilitation. The local society can help and advise planners in their work of adjusting the environment and can bring wisdom from the past without, one hopes, imposing that as a dead weight on the future.

The Education Act, 1944, assigns 'secondary' status to many schools hitherto primary, and in these the education, for the less bookish, must be to a considerable extent visual. Members of local societies can help in the schools to spread knowledge of the locality, can guide school parties, promote local museums of folklife, publish books and booklets that will help teachers and pupils to understand their locality ; and the British Association can help with advice on such work ; it could also organise short conferences in many towns and cities which cannot quite manage the full annual conference, sending delegates specially chosen because of the help they can give. Contacts spread over a few days and extending into the field as well as the lecture room can be more vitalizing and have a more enduring effect than visits of a lecturer for one evening's meeting.

Co-operative research on land utilization, on interpretation of Domesday and other historical surveys, on local names and implements, land tenures and field systems can all be made to help rehabilitate social life. Much of this work can find expression not only in the transactions of local societies, but also in local museums made intelligible to the public, in improved education with partnership between the societies and the teachers and pupils, as well as in scientific contributions to a National Atlas of Britain, a new survey of land utilization and many other efforts of both planners and historical and scientific searchers.

NEWS and VIEWS

Death of President Beneš

By the passing of Dr. Eduard Beneš on September 3 at the age of sixty-four, Czechoslovakia loses its former president, and the world loses a cultured and learned man who had striven for the welfare of all mankind during the past forty years. Born in the Bohemian village of Kožlany on May 28, 1884, Beneš studied philosophy, philology and sociology at Prague and later at Dijon, where his thesis was "Le problème autrichien et la question tchèque". Beneš then spent a short time in London and Berlin before returning to Prague, where he attracted T. G. Masaryk's attention. In 1915 Beneš escaped to Geneva, and with Masaryk and Štefánik (a Slovak astronomer who became an air force general and Czechoslovak War Minister) organised Czech resistance to the Central Powers. Beneš became Czechoslovak Foreign Minister of the first provisional Government, and after the republic was established in October 1918, he retained that post in successive administrations until he succeeded Masaryk as president in 1935. His work became more arduous with the rise of Nazism in Germany, and Beneš had soon to face another exile. Returning in 1945 as president of liberated Czechoslovakia, he was confronted with greater problems than before, since war and occupation had brought more distress than the First World War. The strain of post-war anxieties, the events of February last and Jan Masaryk's suicide, deeply affected him. President Beneš, who had always maintained an interest in learning and culture (especially in the social sciences) made his last public speech on April 7, at the sexcentenary celebrations of the University of Prague (see *Nature*, May 1, p. 670). Among the exhibits in connexion with these celebrations were several items associated with Benes' academic life, including the original Dijon thesis. Since February, President and Mme. Beneš had lived in their country house at Ústí Sezimovo in south Bohemia and had taken no part in public affairs, although he did not resign from the presidency until June 7. Like the Masaryks, Beneš was a 'great European' with wide vision, and though his work for greater understanding among peoples seems recently to have been in vain, he has shown mankind the way.

Presentation to Sir John Parsons, C.B.E., F.R.S.

At a ceremony held in the Royal College of Surgeons on September 3, Sir John Parsons was presented with his portrait in oils, painted by Mr. John Gilroy. The presentation was made by Sir Stewart Duke-Elder, in the name of the members of the Faculty of Ophthalmologists and the Ophthalmological Society, and to mark the celebration of Sir John's eightieth birthday. It is good that Sir John's long and strenuous career has met with such a fitting and happy culmination, for he has long been the acknowledged leader in all aspects of British ophthalmology —clinical work, basic research and public activities. For more than a generation he has been the recognized leader in the clinical practice of this specialty, and opthalmologists of a much wider circle than Great Britain to-day treat their patients better because of his precepts and his writings. So long as ophthalmology is a science, his name will be remembered for the work he did fifty years ago as a pioneer in ophthalmic pathology. To-day he is still the foremost authority in the fundamental sciences concerning vision—biological, physiological and psychological. In guiding, stimulating and encouraging ophthalmic research he has in his time stood out almost alone. In all problems concerning vision successive Governments and industry have asked and received his help ; he served in the two World Wars, in the First as consultant to the Army, in the Second as adviser to the Royal Air Force ; in international ophthalmology he has consistently been an acceptable and gracious British ambassador ; and for years he was the dominant figure in the social and political life of the ophthalmologists of Britain.

Probably, however, the greatest contribution which Sir John Parsons has made is the historical continuity he has succeeded in maintaining between the past and the future. In his youth, ophthalmology in Britain was great among the nations ; but later—largely because with the evolution of science, individual effort had to give place to organised effort for which we were not prepared or equipped—ophthalmology undoubtedly lost its place in Britain. He was largely responsible for reinvigorating it to what may be a future as great as or greater than its past. To-day those who have eyes to see may discern the beginnings of the fruits of his labours. Thirty years ago he was responsible for interesting the Medical Research Council in ophthalmological problems, and to-day these are fully consolidated. Twenty years ago he endeavoured to bring about an amalgamation of London hospitals and inaugurate a research institute ; to-day, that is an accomplished fact. He was primarily responsible for the inauguration of the Faculty of Ophthalmologists, and to-day it is growing lustily. To him and to all of us these promising developments of his ambitions ought to be a source of satisfaction.

Physiology at the London Hospital
Prof. D. T. Harris

Prof. D. T. Harris, on whom the title of professor emeritus has been conferred by the University of London, is to retire at the end of the present session from the chair of physiology which he has held at the London Hospital for the past sixteen years. Prof. Harris studied physics as a special subject at Cardiff, where he took his B.Sc. in 1904. He graduated in medicine at Manchester in 1914 and after holding various hospital appointments and experiencing general practice served as a temporary captain in the R.A.M.C. After a short period as lecturer in physiology at Manchester under Prof. William Stirling, he joined the Institute of Physiology at University College, London, where he held a Beit Memorial Research Fellowship and as Sharpey Research Scholar came under the influence of Sir William Baylis and Prof. E. H. Starling. He obtained the D.Sc. London in 1926 and held the post of assistant professor of physiology in University College, London, when he was appointed to the chair at the London Hospital in 1932. Throughout his academic career Prof. Harris has maintained his interest in physics, his scientific work being mainly concerned with problems arising in the territory bridging physics and physiology, and in particular with the biological action of ultra-violet radiations and ultra-short waves. His contributions to knowledge of these subjects have been published in a series of papers in the *Journals of Physiology, Biochemistry* and *Scientific Instruments*, and his text-book on "Ultra-Violet Radiation" is widely used by operators of ultra-violet lamps who wish to study underlying principles and methods of measurement. In another direction he applied his knowledge of physics to his hobby—photography—and this brought him in contact with the scientific research workers in the cinematograph industry, to whom he gave a series of lectures on stereoscopy.

In the immediate post-war period of intensified university education of 1919–22, Prof. Harris found full scope for his exceptional and natural aptitude for teaching. Large numbers of medical students, and in particular the ex-Service group who came back to complete their medical studies under a sense of urgency to make up for lost time, have cause to be grateful to him for the personal interest he took in their problems and for the systematic clarity of exposition which characterized his lectures and the practical courses he gave for the examinations of the University of London and the Royal Colleges. His book on experimental physiology is used by students in many parts of the world. As a teacher and examiner, Prof. Harris has played a notable part in medical education during the past thirty years, and his many friends will be gratified to learn that, even after his retirement from the London Hospital, he will actively participate in the developments in the teaching of physiology sponsored by the Royal College of Surgeons.

Agricultural Research Council: Lord Rothschild

THE Committee of the Privy Council for Agricultural Research has appointed Lord Rothschild to be chairman of the Agricultural Research Council in succession to Lord De La Warr. Lord Rothschild was born in 1910 and was educated at Harrow and Trinity College, Cambridge, of which he was a fellow during 1935–39. He served in the Army Intelligence Corps during the War and was awarded the George Medal in 1944; was mentioned in dispatches and received the American Bronze Star and Legion of Merit. Lord Rothschild is a biologist, who has carried out research work in the Department of Zoology at Cambridge and has published a number of scientific papers; he has also agricultural interests. He is a member of the boards of the British Overseas Airways Corporation and the Overseas Food Corporation.

Central African Scientific Liaison Office: Mr. R. McChlery

ON September 1, the Central African Council established, on behalf of the Governments of Southern Rhodesia, Northern Rhodesia and Nyasaland, a Central African Scientific Liaison Office in the British Commonwealth of Nations Scientific Offices, Kingsway, London. This arrangement whereby three Colonies, acting jointly, follow the lead of the Dominions by appointing a scientific liaison officer to London provides an interesting new phase in the developing pattern of Commonwealth scientific relations. Mr. R. McChlery, who becomes the first Central African scientific liaison officer in London, went from school at Salisbury, Southern Rhodesia, to take a science degree at Rhodes University College, Grahamstown. He was then awarded a Rhodes Scholarship and proceeded to Exeter College, Oxford, where he obtained the B.A. degree in chemistry in 1925 and the B.Sc. degree in 1926. Following a short course of study at Rothamsted Agricultural Research Station he returned to Southern Rhodesia to join the Chemistry Branch of the Department of Agriculture, where he has since been employed, mainly on problems connected with soil fertility and crop production.

Oxford Science

Oxford Science makes a welcome reappearance after an absence of nearly nine years. Under the general editorship of F. A. Holland, it gives a survey of scientific development in the University of Oxford and is particularly designed to keep the person with a scientific education informed of the progress made in fields of science other than his own. Articles in the present issue (2, No. 1, June 1948) are by A. J. Birch and D. K. C. MacDonald on metal-ammonia solutions; C. J. Dickenson on functional organisation within the cell; J. D. Dunitz and S. C. Wallwork on some developments in structural chemistry; A. H. Cooke on magnetism at low temperatures, and H. M. Sinclair on nutritional science. In the editorial, reference is made to the part played by Oxford men of science in the nation's war effort, to the new laboratories under construction or about to be constructed, and to the closing down of the last of the college laboratories, so that laboratory teaching is now entirely in the hands of the University staffs. Only brief mention is made of the important physical work done in the new Clarendon Laboratory; but a fuller report can be found in *Oxford*, 9, No. 2, p. 54 (1946–47). Those interested in the progress of chemistry at Oxford may like to refer to the article by F. M. Brewer in *Oxford*, 9, No. 3, p. 98 (1948), which is very informative.

United States Book Exchange

A BUREAU for the international exchange of books and periodicals between libraries, scientific and educational institutions of the United States and other countries has been opened in the Library of Congress, Washington, D.C. The organisation, known as the United States Book Exchange, is a successor to the American Book Centre for War Devastated Libraries, Inc., and the executive director is Miss Alice D. Ball, formerly acting director of the Book Centre. While the new organisation will continue the rehabilitation programme of the Book Centre, libraries of foreign countries are expected to become members of the new Book Exchange and contribute material to the programme as well as draw from it. During the past two and a half years, more than 1,250,000 volumes have been sent out by the Book Centre, to war-devastated libraries in thirty-one countries. At first the activities of the Book Exchange are being limited to printed matter of scientific or literary character; this will include books, pamphlets, periodicals, government documents, music, printed leaflets, and occasional papers. At present no microfilm and microprint will be dealt with, and no motion pictures, art reproductions and newspapers; but it is hoped eventually to handle all types of printed and filmed material.

Mitigation of Spray Injury

IT is an essential prerequisite of a fungicidal spray that it should not itself cause damage on the plants to which it is applied. This is, unfortunately, not always the case, for lime-sulphur sometimes causes early leaf-drop on the apples Cox's Orange Pippin and Worcester Pearmain. M. H. Moore has shown (*J. Pom. and Hort. Sci.*, 23, 3 and 4, Dec. 1947) that this damage can be greatly reduced by adding 4 lb. of ferrous sulphate crystals to every gallon of lime-sulphur concentrate before dilution. Sprays against apple scab were made according to the usual schedule. The relative effects of calcium arsenate and lead arsenate separately mixed with lime sulphur as post-blossom sprays were also estimated. Calcium arsenate powder proved more toxic to the apple leaves than lead arsenate paste of much less arsenic oxide equivalent. The inclusion of ferrous sulphate in the mixtures, however, reduced the leaf-drop; but did not markedly prevent fruit-drop. Zinc sulphate provided no suitable alternative to ferrous sulphate; it was highly phytotoxic.

Parallelism between Atomic and Planetary Properties

A SHORT article with the above title in *Nature* of May 15, p. 780, directed attention to the formulation by M. F. Prunier of a wave equation for astronomical planetary systems similar to Schrödinger's equation for atomic systems. It has just been brought to our notice that a somewhat similar hypothesis had been put forward earlier by Mr. B. Liebowitz, of New York (*Phys. Rev.*, 66, 343; 1944). His equation is satisfied by a variable which he calls the "probability of presence". The subsequent development, very surprisingly, seems to show that for a purely classical problem concerning the planets, akin to Bode's law, using purely classical arguments, an equation can be obtained which has the same form and meaning as Schrödinger's essential non-classical equation. But, in sharp opposition to the conclusion of M. Prunier, Mr. Liebowitz says that there is no implication of a magnetic moment associated with the angular momentum. It will be recalled that the possibility of such a relation, particularly for the earth's magnetism, has been much discussed since Prof. Blackett's article in *Nature* (**159**, 658; 1947) was published.

The Coco-nut Research Scheme

THE annual report for 1944 of the Coco-nut Research Scheme (Government Record Office, Colombo, Ceylon, 40 cents, 20 pp., Jan., 1948) shows that in addition to many routine analyses of copra and coco-nut products, a more detailed examination of the dry distillation of coco-nut shells has been made. The yield of pyroligneous acid was 38·2 per cent and of settled tar, 5·6 per cent. Total acid (as acetic) accounted for 11·6 per cent of the pyroligneous acid, which also contained about 3 per cent of wood spirit. An attempt to use coco-nut shells as a starting material for the preparation of furfurol gave rather poor yields. Manurial experiments with nitrogen, phosphorus and potash indicate that only the potash increased the yield of copra, beginning at the fourth year from commencement of applications. On poor soils, complete manuring with all three major nutrients gave a marked increase in the number of female flowers. Various other experiments on cultivation are also described in the report.

The Royal Anthropological Institute

THE report of the Council of the Royal Anthropological Institute for July, 1947–June, 1948 has appeared. It is pleasing to gather that real progress has been made in all directions. The Institute has always been handicapped through lack of means and in other ways. Though these disabilities have by no means all been overcome, improvement can be clearly noted. The membership is rising, and the library is now in better order. Much activity has been shown in many directions. The Institute fulfils an important function in a country like Great Britain which lies at the centre of a great Empire, and every effort should be made to help it to do what it alone can accomplish for the study and understanding of the many primitive peoples it is still our lot to sustain.

Erdoel und Kohle

THE former German oil journal, *Oel und Kohle*, has now appeared under the title *Erdoel und Kohle* (von Hernhaussen, Hamburg; annual subscription, 60 marks). The first issue of 56 pages was brought out by Dr. Karl Zerbe in June. Its contents cover the future problems of petroleum geology and geophysics and the possibilities of applying secondary recovery methods. In the refining section there are articles on the progress of hydrocarbon synthesis and dewaxing. Scientific abstracts and short commercial notices are included. This journal is the official organ of several technical associations.

Seventh Pacific Science Congress

THE Seventh Pacific Science Congress will be held in Auckland and Christchurch, New Zealand, under the auspices of the Royal Society of New Zealand, and with the assistance of the Government of New Zealand, during February 2–22, 1949. As in previous Congresses, members will be classified as official members (delegates representing the constituent countries of the Pacific Science Association and specially invited guests), members (accredited by scientific bodies) and participants. The Congress will be organised in ten divisions, and within divisions there will be a varying number of sections. The programme is arranged in the form of symposia for the discussion of topics of wider interest for the Pacific peoples; within divisions, subjects of specialist or technical interest will be presented at section meetings. Among the subjects for symposia are: structure of the Pacific basin; Antarctic and Pacific meteorology; oceanography and fisheries of the Pacific; biogeographical provinces; soil resources; ethnographic studies in Micronesia; medical and nutritional problems of the Pacific area. The president of the Congress is Mr. R. A. Falla, president of the Royal Society of New Zealand and director of the Dominion Museum, Wellington; the secretary-general is Mr. Gilbert Archey, director of the Auckland Institute and Museum, Auckland, S.E.1, to whom all communications should be addressed.

Announcements

THE Queen has been graciously pleased to accord her patronage to the Royal Society of Edinburgh, of which H.M. the King is patron.

AT the National Gallery, London, Mr. Martin Davies, who is chiefly in charge of the library, and Mr. Ian Rawlins, scientific adviser, have been appointed deputy keepers.

MR. J. V. CONNOLLY, who has served since 1937 at the Air Ministry, Ministry of Aircraft Production and Ministry of Supply, recently as assistant director of aircraft production, has been appointed professor of aircraft economics and production at the College of Aeronautics.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Creep of Metals and Recrystallization

THERE has been a certain amount of dispute as to the fundamental laws of creep of polycrystalline metals[1]. I have advanced the view that the normal creep of a rod extending longitudinally under constant stress can always be represented fairly closely by the formula

$$l = l_0(1 + \beta t^{1/3})e^{kt},$$

where l is the length at time t, l_0 is approximately the initial length and β and k are constants. This gives a final rate of extension per unit length which tends to become approximately constant. On the other hand, it has been contended that there is a final state of accelerated creep, called[2] by some metallurgists Stage 4. When the total extension is of some per cent, this stage is often obtained in tests at constant load and can then, on my view, be attributed to increasing stress, consequent upon the thinning of the specimen. As argument against this, it has been pointed out that the increasing rate of creep has been obtained with extensions of less than 1 per cent in the case of certain steels at high temperature (see Fig. 1)[3]. This I have, however, attributed to recrystallization during the process of creep, recrystallization having been shown to produce increased rate of flow in certain cases[4].

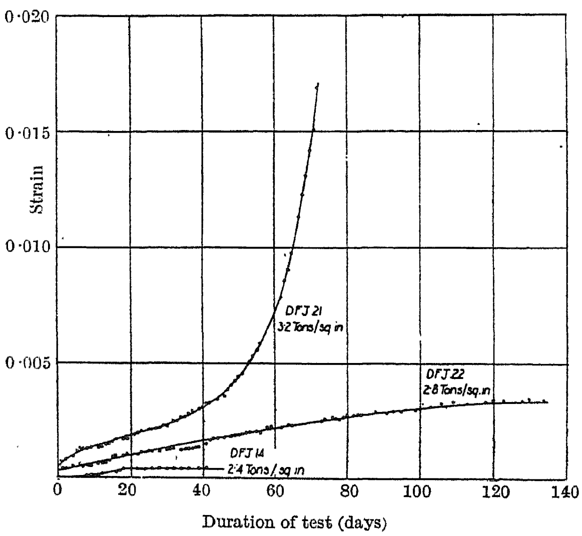

Fig. 1. Creep of a high-nickel-high-chromium steel at 800° C.

Certain experiments which Miss Charmian Sinclair has been carrying out with me on the flow of metals under constant stress throw light on this point. The metal in question is a pure lead (Tadanac virgin lead, of purity approximately 99·99 per cent) which was prepared by extrusion at 100° C. and kindly supplied to me by Mr. G. L. Bailey, director of the British Non-Ferrous Metals Research Association. It turns out that this metal, although normally stable at atmospheric temperature, recrystallizes under stress, the crystals increasing in size from about 0·05 mm. up to about 0·3 mm. linear dimensions.

Fig. 2 shows length against time for a range of stresses, each stress being maintained constant during flow by an Andrade–Chalmers constant stress bar[5]. It will be seen that the form differs markedly from that obtained with normal metals, which is represented by the broken line, obtained with normal lead extended at about the same temperature at constant stress. For the recrystallizing lead there is a stage of accelerated creep during the first ten minutes which is followed by a final creep at an approximately constant rate. The form of creep curve during the first ten minutes resembles closely that for the steels at high temperature. Whether the steels would, at like extension, ultimately creep at constant rate, cannot be said, but the 2·8 tons/sq. in. curve suggests that it may be possible.

It is clear, in any case, that recrystallization during creep has a fundamental effect on the form of creep curves. So far we have examined the wires microscopically only before and after creep, and noted the very marked recrystallization that has taken place. We are about to examine the state of crystallization at different stages of creep, with the object of connecting the rate of creep with the process of recrystallization.

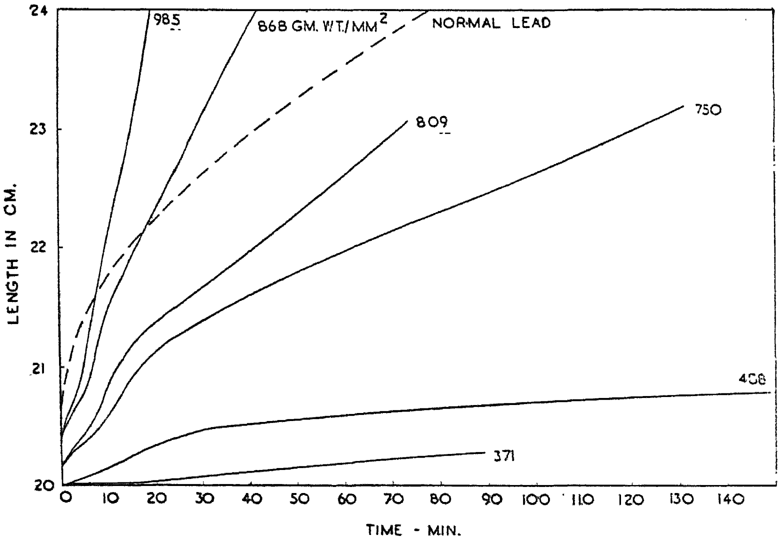

Fig. 2. Creep of a very pure lead which recrystallizes under stress

E. N. DA C. ANDRADE

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June 29.

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[1] For example, *Nature*, **157**, 469 (1946).

[2] Hanson, D., Amer. Inst. Mining and Met. Eng. Tech. Pub. No. 1071.

[3] Tapsell, H. J., and Remfry, J., D.S.I.R. Engineering Research Special Report No. 15 (1929).

[4] For example, Bristol Conference Report, Physical Society (in the press).

[5] Andrade, E. N. da C., and Chalmers, B., *Proc. Roy. Soc.*, A, **138**, 348 (1932).

Creep of Metals Subjected to Compression Stress

THE progress of creep in metals in the case of applied tensile stress is usually divided into three stages: (1) an initial decelerating rate of creep (primary creep); (2) a stage of approximately constant creep-rate (secondary or steady state creep); (3) a final accelerating state of creep, leading to fracture (tertiary creep often ascribed in materials undergoing large deformations to increase in stress due to decreasing cross-sectional area as creep proceeds).

We have conducted creep tests in compression at a constant load on some typical creep-resistant nickel-chromium alloys, which in tensile creep tests at the same initial stress and temperature show the three stages of creep referred to above. During the course of these tests, we have made the following observations:

(*a*) The creep-rate in the secondary or constant state stage of creep is approximately the same in tensile and in compressive tests.

(*b*) Tertiary creep occurs in compression as well as in tension, and its onset in compressive tests occurs at approximately the same time as in tensile tests.

(*c*) Whereas in tensile tests, creep in the tertiary stage proceeds at an accelerating rate until fracture ensues, in corresponding compressive tests creep proceeds in a series of accelerating and decelerating rates.

Fig. 1 illustrates a typical compressive creep test showing primary and secondary creep, the onset of tertiary creep, and a stage of decelerating and accelerating creep in the tertiary stage. Fig. 2 is a comparison of the tensile and compressive creep of samples of identical alloy under the same conditions of stress and temperature. The accelerating rate of tertiary creep in the tensile specimen and the stages of acceleration and deceleration in the tertiary creep stage of the compressive creep specimen should be noted.

We believe that this is the first observation of tertiary creep in compression tests. The fact that it occurs after the same time has elapsed in both tension and compression tests suggests that its onset in tension tests in these materials is in no way connected with the increase in stress resulting from a reduction in effective cross-sectional area due to creep. Increase in stress due to decrease in cross-sectional area is, of course, a factor accelerating creep in materials such as pure metals tested at stresses that cause relatively large deformations to occur during the creep test.

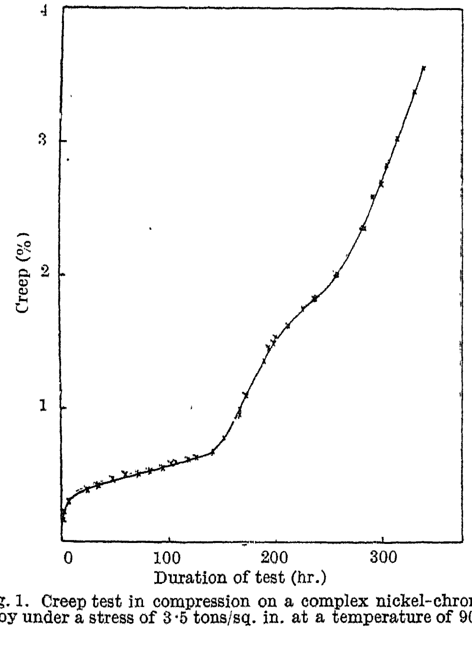

Fig. 1. Creep test in compression on a complex nickel-chromium alloy under a stress of 3·5 tons/sq. in. at a temperature of 900° C.

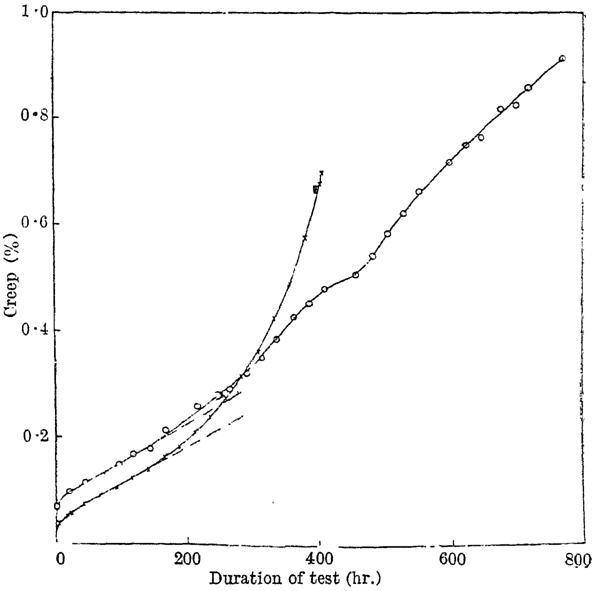

Fig. 2. Comparison of tensile and compressive creep under a stress of 9 tons/sq. in. at a temperature of 815° C. x, tension creep test; o, compression creep test

It is suggested that a study of the differences between tensile and compressive creep in the tertiary stage may enable certain deductions to be made about the mechanism by which this stage of creep occurs. We tentatively suggest that, in both tension and in compression, tertiary creep is initiated by atomic rearrangement in the most heavily strained zones adjacent to the crystal boundaries, the onset of which may be determined by the amount of strain which the specimen has undergone. This rearrangement may represent the initial stages of a recrystallization process similar to that which has been stated by Greenwood and Worner[1] to be responsible for successive stages of accelerating and decelerating creep in tensile creep tests on lead and lead alloys. If this acceleration of creep-rate occurs by slip processes in the zones adjacent to the boundaries, it will lead to misfit at grain boundaries and, in the case of applied tension, to the formation of fissures at the grain boundaries at large angles to the applied stress, causing a further acceleration of creep-rate and rapid fracture. The formation in tension of such fissures at or near the grain boundaries and an accompanying decrease in density have been demonstrated by Hanson and Wheeler[2].

In compressive creep, we suggest that such fissures in boundaries making large angles to the direction of the applied stress cannot form as readily as in the case of tensile creep, so that creep may proceed by a series of hardening processes, due perhaps to the blocking of dislocations, and to recovery processes akin to the onset of recrystallization. These hardening and recovery processes may be localized in material adjacent to the grain boundaries, due to the stress concentrations in these regions brought about by flow in the boundaries.

We intend to make further correlation of compressive and tensile creep in materials free from the metallurgical complexities of commercial creep-resistant alloys, in order to obtain further data.

We are indebted to the Ministry of Supply, under the sponsorship of which the work was conducted, for permission to publish these results, and to Mr. W. H. Mayes, who was responsible for the construction of the apparatus, which was similar in principle to a machine in use at the National Physical Laboratory.

A. H. Sully
G. N. Cale
G. Willoughby

Fulmer Research Institute, Ltd.,
Stoke Poges, Buckinghamshire.
July 6.

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[1] Greenwood, J. N., and Worner, H. K., *J. Inst. Metals*, **64**, 135 (1939).

[2] Hanson, D., and Wheeler, M. A., *J. Inst. Metals*, **45**, 229 (1931).

Isotopic Assignment of the α-Activity of Samarium

The recent report by Dempster[1] that the earlier conclusion of Wilkins and Dempster[2] regarding the α-active isotope of samarium is unreliable makes necessary the revision of a great deal of past speculation. Previously the α-activity was assigned to ^{148}Sm ; now it appears that ^{152}Sm is almost certainly the isotope responsible.

It is the object of this note to point out that (once the shock of this radical re-assignment is forgotten) the new result is more easily reconcilable with other evidence than is the old. Earlier arguments attempting to explain why the range of elements neodymium (60) to samarium (62) is particularly liable to α-disintegration, and seeking to compare this range of elements with that neighbouring upon polonium (84), the most α-unstable of the classical radioelements, are not affected; but the details of the picture are filled in with much greater consistency than before.

The outside evidence of most direct relevance is that regarding isotopic hyperfine structure in the spectra of neodymium and samarium. With samarium, Schüler and Schmidt[3] found an anomaly in the relative separations of the isotopic hyperfine structure components; later a closely similar anomaly was found by Klinkenberg[4] with neodymium. For all other even-numbered elements so far examined the isotopic hyperfine structure consists of components which to a good approximation are linearly spaced in respect of mass number on a frequency scale (at least so far as the components of even mass number are concerned). With samarium this linear spacing is interrupted by an abnormally large interval between the components of mass numbers 150 and 152, and with neodymium there is similarly an unusually large interval between components of mass 148 and 150. Basically these anomalies are interpreted as evidence for an abnormal increase of nuclear radius (more exactly of the proton-occupied volume of the nucleus) between ^{150}Sm and ^{152}Sm, as also between ^{148}Nd and ^{150}Nd ; scarcely less directly they may be regarded as evidence for a 'discontinuous' decrease in nuclear binding energy as between these pairs of even isotopes. Classifying on this basis the samarium isotopes of mass numbers 144, 148, 150 and the neodymium isotopes 142, 144, 146 and 148 as 'tightly bound' and the samarium isotopes 152, 154 and the neodymium isotope 150 as 'loosely bound', it is clear that the only possibility for α-disintegration from a loosely bound samarium to a tightly bound neodymium is, in fact, the possibility $^{152}\text{Sm}\xrightarrow{\alpha}{}^{148}\text{Nd}$. There is every reason to expect, therefore, that ^{152}Sm is the predominantly α-active samarium isotope. A tentative suggestion to this effect was, in fact, made by Schüler and Schmidt[3] in 1934.

Returning to the comparison of the α-activity of samarium with that of the classical radioelements—and with the α-activities of the polonium isotopes in particular—we may note how recent results serve to correct previous misconceptions. Previously it has been too readily assumed that α-activity becomes more pronounced as the mass number (A) decreases; for polonium (84), at least, the work of Howland, Templeton and Perlman[5] shows that this is not the case. The annexed table gives the total energy of α-disintegration (E) of the isotopes from A = 206 to A = 218. The pattern of variation is obvious from the figures quoted. The 'pure α-active' species for this element (Z = 84) are the isotopes of mass numbers 208, 210, 211, 212, 213 (?), 214 and 216; these are the species which correspond to the stable isotopes of the elements[6] of atomic number $Z \leqslant 83$. It is clear that the maximum α-disintegration energy in this case (Z = 84) belongs to the even-numbered isotope, which occupies the mid-place in the sequence of β-stable species A = 208, 210, 212, 214, 216. The case of samarium is seen in comparison to be not so different as might previously have been supposed.

A	206	207	208	209	210	211	212	213	214	215	216	217	218
E (MeV.)	5·3	5·2	5·24	?	5·40	7·58	8·95	8·45	7·83	7·51	6·90	(6·45)	6·11

N. Feather

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University of Edinburgh.
July 26.

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[1] *Phys. Rev.*, **73**, 1125 (1948).

[2] *Phys. Rev.*, **54**, 315 (1938).

[3] *Z. Phys.*, **92**, 148 (1934).

[4] *Physica*, **11**, 327 (1945).

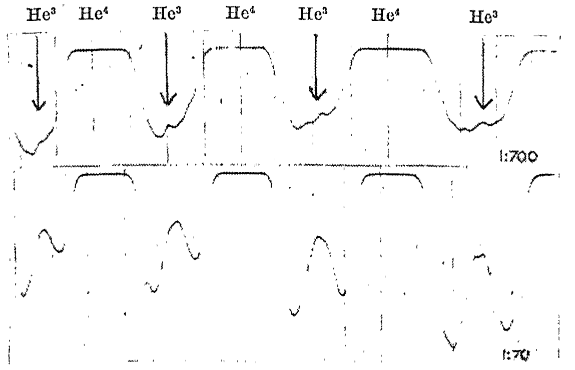
[5] *Phys. Rev.*, **71**, 552 (1947).

[6] Turner, *Phys. Rev.*, **57**, 950 (1940); *Rev. Mod. Phys.*, **17**, 292 (1945); Feather, *Rep. Prog. Phys.*, **11** (1948).

Spectrum of Helium-3

The possibility of obtaining samples of helium in which the isotope of mass 3 has been enriched allows the isotope shifts in the arc spectrum of this element to be investigated. The first samples, which had kindly been made available to us by Dr. Rollin and Mr. Hatton[1], had been prepared by means of thermal diffusion, and contained helium-3 in a concentration of 1 : 700. With an ordinary Fabry Pérot étalon, the detection of satellites several hundred times weaker than the main line is impossible, owing to the finite background intensity of this instrument. This difficulty was overcome by the use of two étalons, of equal spacings, in series. By suitable choice of apertures, distances and orientations of the wedge-shaped étalon plates, it was found comparatively easy to avoid secondary reflexions. The method appears to be very useful for the investigation of faint satellites very close to strong lines.

The upper part of the figure shows a photometer tracing of the line 2^1S–3^1P, 5015 A., photographed with two étalons in series, each of spacing 0·318 cm. The peaks due to helium-3 are small, but clearly visible between the large peaks of helium-4, which appear flattened at the top as the result of over-exposure. A sample in which the helium-3 had been



further enriched to a concentration of 1 : 70 by the method of evaporation at very low temperature[1] became available later, and its spectrum is shown in the lower part of the figure. Comparison of the two tracings demonstrates the enrichment achieved by this method. Rough photometric estimates of the intensities agree with the concentration of the samples measured in the mass spectroscope.

The background which appears in the tracings is largely due to the finite width of the helium lines, not to instrumental effects. The intensity ratio 1 : 700 does not, therefore, represent the limit of sensitivity of the method.

In the highly enriched sample, the satellite could also be photographed and measured with a single étalon. The helium-3 line was found to have a separation of $-0{\cdot}83 \pm 0{\cdot}03$ cm.$^{-1}$ from the helium-4 line.

A theory of isotope shifts in two-electron spectra due to mass effects has been developed by Hughes and Eckart[2,3]. It is based on the assumption of hydrogen-like wave functions with effective nuclear charges. On the basis of their calculations for the $2P$ states, the value of the effective charge Z_s for the $1s$ electron in the $3P$ states can be assumed to be 2·00, giving a value of $Z_p = 0{\cdot}996$ for the $3p$ electron in the 3^1P state. This gives an isotope shift of the line 2^1S–3^1P of $-0{\cdot}77$ cm.$^{-1}$, which is outside the limits of error of the experimental value. The difference may be due to the approximations contained in the theory, or to the influence of factors other than the pure mass effect.

Details of the spectroscopic method will be published elsewhere.

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H. KUHN

Clarendon Laboratory,
Oxford. July 22.

* Rhodes scholar.

[1] Rollin, B. V., and Hatton, J., *Phys. Rev.* (in the press).

[2] Hughes, D., and Eckart, C., *Phys. Rev.*, **36**, 694 (1930).

[3] Eckart, C., *Phys. Rev.*, **36**, 878 (1930).

Vibrating Electrodes in Polarography

THE constant diffusion conditions necessary for polarographic work have hitherto been attained by use of the dropping-mercury electrode, the streaming mercury electrode[1], the rotating platinum micro-electrode[2], or even by a fixed micro-electrode and a constant electrolyte streaming-rate[3].

We have found that a platinum micro-electrode vibrating at a constant frequency (100 cycles per second) with an amplitude considerably greater than its linear dimensions gives constant diffusion conditions, and with such an electrode we have obtained reproducible polarograms. The electrode is free from irregularities due to external vibration and gives smoother curves than those obtained with the dropping-mercury cathode.

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Jewry Street, London, E.C.3.

[1] Heyrovsky, J., *Chem. Listy*, **40**, 222 (1946).

[2] Laitinen, H. A., and Kolthoff, I. M., *J. Phys. Chem.*, **45**, 1079 (1941).

[3] Muller, O. H., *J. Amer. Chem. Soc.*, **69**, 2992 (1947).

Evidence of Geological Age against Decay of Tin-115 to Indium-115 by Electron Capture

ACCORDING to a rule of nuclear stability, it is improbable that two neighbouring elements (neighbouring Z) have stable isotopes of the same nominal mass, that is, stable neighbouring isobaric pairs should not exist. A few apparent exceptions to this rule are known, one of which is the pair, ${}_{49}\mathrm{In}^{115}$ and ${}_{50}\mathrm{Sn}^{115}$.

In indium, the relative abundance of In^{115} is 95·5 per cent, and in tin, the relative abundance of Sn^{115} is 0·4 per cent: In^{115} is thus an abundant indium isotope, whereas Sn^{115} is a minor tin isotope; this has caused some nuclear physicists, for example, Fluegge[1], to suggest that Sn^{115} has probably decayed by orbital electron capture to In^{115} during the life-period of the earth.

Recently Kohman[2] has discussed β-stability of all nuclei, and by means of his β-stability diagram has been able to predict that for the pair, Sn^{115} and In^{115}, Sn^{115} should be unstable, which accords with the above suggestion by Fluegge[1]. Kohman[2] refers to an earlier paper by Eastman[3], which, on the basis of atomic mass calculations, would also favour decay of Sn^{115} to In^{115}. A later paper by Eastman[4] invokes geochemical evidence, namely, the association of traces of indium with tin in tin minerals, as indicative of electron capture decay to indium-115. Since this publication appeared, many more tin minerals have been analysed, notably cassiterite; in some, traces of indium have been found, whereas in others no indium could be detected. Of considerable interest is a paper by Itsikson and Rusanov[5] which reports analyses of many specimens of cassiterite from the U.S.S.R.: the useful conclusion is made that although specimens of cassiterite associated with sulphide veins usually contain traces of indium, specimens from pegmatite are likely to be free from detectable quantities.

Direct observations on the production of characteristic X-radiation which would result from electron capture decay by tin-115 have been made by Zingg[6]. His results are inconclusive, as, in three specimens of tin he examined, very feeble activity could be detected, whereas in a fourth specimen no activity was observed. Later, similar observations by Rusinov and Igelnitzky[7] failed to reveal the presence of any X-radiation, and these authors set the minimum value for the period of half-life (T) for Sn^{115} as greater than $1{\cdot}0 \times 10^{13}$ years.

As a result of the considerable diversity of opinion and experimental evidence mentioned above, I have attempted to utilize geochemical evidence of the type referred to before, for establishing whether significant decay of tin-115 by electron capture decay has taken place or not. For this purpose, three requirements have to be fulfilled: the absolute age of the mineral has to be known; this age must be extremely great—

if possible, of the same magnitude as the age of the earth—and, finally, contamination by non-radiogenic indium has to be reduced to an absolute minimum.

The age of the earth appears very likely to be of the magnitude of 3,000 × 10^6 years, according to Holmes,[8] Houtermanns[9] and some astronomical data, and minerals of the greatest geological age yet reported are, according to Ahrens[10], from pegmatites in south-eastern Manitoba, Canada: the age of these pegmatites from this area is given as 2,100 × 10^6 years and is based on strontium and lead age measurements. These pegmatites are thus of extreme age, the magnitude of which is comparable with the age of the earth. In greisenized portions of some of these pegmatites, cassiterite occurs, and according to Itsikson and Rusanov[5], pegmatitic cassiterite is likely to be freest from the presence of even traces of indium. Consequently, a spectrochemical analysis was made of a specimen of cassiterite from pegmatite (south-east Manitoba), which had been kindly supplied by the Department of Mines and Natural Resources, Winnipeg, Canada. Only a doubtful trace of indium was observable, equivalent in quantity to the limit of detection for the spectrochemical determination of indium in cassiterite, which, with the aid of a series of standards, was estimated to be very close to 0·0001 per cent indium. This value represents the maximum concentration of indium in the specimen of cassiterite, and as the tin content of pure cassiterite is about 75 per cent Sn, the period of half-life (T) for tin-115 is equal to or greater than 5·0 × 10^{12} yr.

From this analysis of cassiterite, several conclusions may be made: (1) The relative abundance of indium-115 (95·5 per cent) in natural indium, and the paucity of tin-115 (0·4 per cent) in natural tin, cannot be attributed to electron capture decay of Sn^{115} during earth periods. (2) The presence of traces of indium in many tin minerals is not due to decay of tin-115 because, even in the oldest known specimen of cassiterite (2,100 × 10^6 yr.), only a doubtful trace (equal to or less than 0·0001 per cent indium) could be observed. (3) Should tin-115 have decayed very feebly indeed to indium-115, the rate of decay is extremely slow, and T (Sn^{115}) is equal to or greater than 5·0 × 10^{12} yr., which accords with the observations of Rusinov and Igelnitzky[7], who determined T as 1·0 × 10^{13} yr. by direct experiment. The spin[11] of In^{115} is 9/2, whereas that of Sn^{115} is 1/2; this difference in spins is very great indeed, and should decay occur, an extremely long life would be expected.

The spectrochemical analyses were made in the Department of Mineralogy and Petrology, University of Cambridge; grateful acknowledgment is made to Prof. C. E. Tilley for providing facilities for carrying out the investigation.

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Human Colour Vision and Granit's Theory

GRANIT's brilliant experiments on electroretinography[1] have led him to postulate photopic and scotopic 'dominator' mechanisms which have all the properties of independent brightness receptors, and 'modulator' mechanisms which may give cues to colour because they are sensitive to relatively narrow bands of the visible spectrum. Many of the animals on which the experiments were done, such as the cat, rat, guinea pig and frog, are totally colour blind to the best of our knowledge; and Granit points out (*a*) that most laboratory animals, with the exception of the snake, possess very few modulators relative to their dominator units; (*b*) that these proportions in the highly colour-sensitive human fovea are not known; (*c*) that the demonstration of modulator units is not in itself a proof of the presence of colour vision.

In a previous communication the factorial analysis of a battery of colour vision tests, including red, orange, yellow, yellow-green, green, blue-green, blue, violet and purple, with corresponding brightness measurements, was reported[2]. This seemed to give strong support to a four-colour theory of the Hering or Houstoun type. There is, however, every reason to suppose that such results might be co-ordinated with Granit's findings.

In a subsequent series of tests, the following results were obtained on a group of 357 subjects with normal colour vision, the brightness readings being separately inter-correlated with the measurements of colour sensitivity, though there was, of course, only a single brightness-level measurement for each colour pair, because the tests were of the Rayleigh equation type.

Test	Factor loadings		
	I	II	III
Red	0·070	+0·767	−0·226
Yellow	0·007	+0·104	−0·451
Green	0·121	−0·683	−0·069
Blue	0·459	−0·061	+0·236
Y-blue brightness	0·179	−0·268	+0·395
R-green brightness	0·252	+0·141	+0·115

It seems reasonable to suppose that factorial analysis would tend to reveal any consistent patterns of variation in the sensitivities of the underlying visual mechanisms, and therefore to indicate their number and nature. In this analysis, as in the other analysis of the results for normal subjects[2], the first factor is light but represents general variabilities irrespective of differential hue sensitivity; the second factor is heavy and represents variability in the bipolar red-green sensitivity; and the third factor is light and represents variations in yellow-blue sensitivity. The variations of brightness sensitivity are distributed among the three factors. 'Blue' and brightness are the best representatives of the general factor; red-green brightness tends to vary with red, but yellow-blue brightness with green in the second factor; both yellow-blue brightness and red-green brightness with blue in the third factor.

It might be suggested that the general factor represents variations in the sensitivity of the dominator mechanism for photopic vision. The second factor would then represent the variations in sensitivity for the red-green modulator unit and the third factor the variations for the yellow-blue modulator unit. Three important conclusions may be drawn from this application of Granit's theory to the result of tests of colour vision upon normal human subjects: (*a*) that four modulators would be sufficient, namely, red, yellow, green and blue; (*b*) that they must be regarded as operating in two bipolar units, red with green, and yellow with blue; (*c*) that brightness is to some extent dependent on the modulator units.

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A Simple Technique for the Differential Staining of Lignified Cell Walls

THE common methods for differential staining of lignified plant tissue are specific when used correctly, but minor errors in procedure may lead to unsatisfactory results. The following simple technique has been found a reliable, cheap and quick supplement to the other methods available, and to give good results in unskilled hands.

It is based on the observation that, in all cases which we have examined, a colourless solution of benzidine imparts an orange or yellow colour to lignified cell walls, but causes no colour change in cellulose or in cutinized or suberized walls. The most intense orange coloration is produced by a saturated solution of benzidine in glacial acetic acid. With lowered acidity the solubility of benzidine decreases, the resulting solutions producing a less brilliant but equally specific staining. This develops in sections after thirty seconds to sixty seconds treatment; but as the solution is colourless and the reaction occurs only in lignified tissue, sections can be left in it for many days without 'overstaining', and there is no need for subsequent washing or 'destaining'. This is an advantage when handling sections in bulk, it being possible to transfer them to the solution directly after cutting and to hold them in it until it is convenient to mount them with or without a light counter stain. A less acid solution may also be used for the vital staining of tissue, as vascular systems of leaves, etc., are clearly visible after impregnation. The colour is unaffected by treatment with alcohol or xylol, and has shown no signs of fading in sections exposed to daylight for three months.

In view of the constitution of benzidine, the chemistry of the staining is possibly similar to that of the colour reaction given by lignified cell walls with a number of primary and secondary amines.

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July, 1948

Influence of Time and Temperature of Storage on Dye-Reduction Tests in Milk

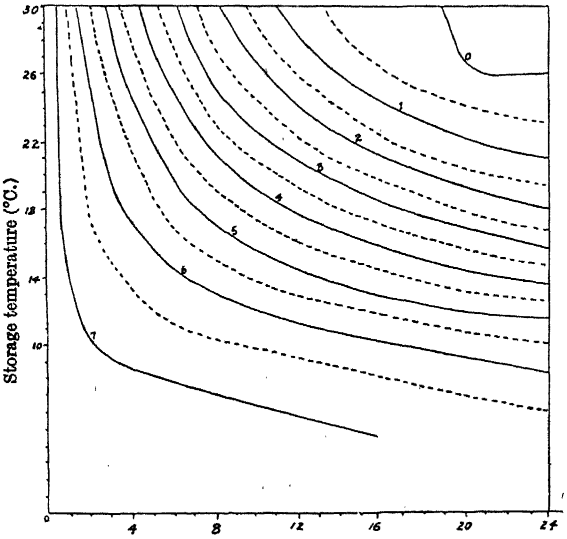
IN applying overseas data to the determination of suitable dye-reduction standards for the grading of milk in New South Wales, it soon became apparent that particular attention would have to be paid to the influence of time and temperature of storage on the reduction time[1]. Apart from Smythe's work in Queensland[2], for a relatively limited storage time, there is surprisingly little information concerning the significance of these factors, and it is thought that our own approach and results will prove of interest beyond Australia.

The primary aim of our work has been to study the trends in decrease of dye-reduction times with storage time and temperature, including within the range of our experiments conditions likely to be encountered both in Australia and Britain. By this means it has been possible to bring to bear on our own problem the large body of British experimental work and practical experience, as well as to arrive at a temperature compensation scale for local variations that are likely to be more extreme than those encountered in the United Kingdom. Samples from six producers, representing extremes of production conditions, were taken at the completion of milking and stored at combinations of time and temperature, namely, 4, 8, 12, 16, 20 and 24 hr. and 0, 10, 14, 18, 22, 26 and 30° C. Methylene blue and resazurin tests (both at 37·5° C.) were then performed on each sample.

With the advice of Dr. D. B. Duncan, of this Department, it has been possible to use the results so obtained to study the trends with storage time and temperature as a regression surface, having twelve parameters and allowing for quadratic variation with storage time and cubic variation with temperature as well as interaction between the two. The results for the modified methylene blue test are shown in the form of a contour graph (reproduced herewith) in which the lines join the points of equal reduction times. From this graph it is possible to arrive at an approximation of reduction time associated with any combination of storage time and temperature; but more fully the surface is represented by the equation:

$$Y = 7{\cdot}2-0{\cdot}005\,t+0{\cdot}00027\,t^2-0{\cdot}047\,T+0{\cdot}019\,tT$$
$$-0{\cdot}00044\,t^2T+0{\cdot}0047\,T^2-0{\cdot}00293\,tT^2+0{\cdot}000039\,t^2T^2$$
$$-0{\cdot}00010\,T^3+0{\cdot}000048\,tT^3-0{\cdot}00000005\,t^2T^3\;;$$

Y is reduction time in hours, t is storage time in hours, T is storage temperature in °C.



Influence of time and temperature of storage on methylene blue reduction time. Lines join points of equal reduction time in hour – half-hour intervals

The surface represented in the graph and the accompanying equation appears, from a consideration of British temperatures (as recorded at Kew), to pass through the British Summer Standard (12 hr. storage at mean summer air temperature of 16° C., reduction time, 4½ hr.). However, the height of the surface can be conveniently altered by adjustment of the constant (7·2 in the above equation) to comply with any other standard.

Similar methods have been applied to data for the resazurin tests obtained on the same milks, thus permitting an accurate comparison of the time—temperature trends together with a comparison of existing British standards for both tests. Our data suggest, in fact, that the standard set for resazurin[3] is appreciably lower than that for methylene blue[4].

Furthermore, by taking account of data for the individual producers, it is possible to determine the degree of discrimination associated with each combination of time and temperature ; so that the storage period can, within certain practical limits, be adjusted to obtain greater sensitivity in the test.

Other advantages of our approach might then be summarized thus. Comparable standards can be established for widely different conditions of production. A reasonable adjustment in acceptable reduction time can be made throughout the year according to temperature and time of storage, thus freeing the test of its present undue dependence on atmospheric temperature[5]. The length of time between production and testing can be allowed for in evaluating producers. The time—temperature effect can be related for several tests.

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Pregnancy Test using the Male Toad

THROUGH the kindness of the originator of the test, who forwarded us a supply of *Bufo arenarum* Hensel, we have recently been able to carry out the Galli Mainini male toad test for pregnancy.

Ten ml. of urine are injected into a lymph sac of the toad. It is important to note that the animals seem particularly susceptible to drugs in the urine. But apart from this fact, the urine samples need no special preparation. The appearance of spermatozoa in the urine, which constitutes a positive result, is observed by low-power microscopic examination of a drop or two obtained by a pipette from the cloaca. We have found the test to be positive in 2–4 hr., depending on the time of examination. In some cases, a positive result occurs in one hour and the amount injected may be reduced to 5 ml. Within 20–24 hr., re-sampling of the urine shows either absence of spermatozoa or fewer and non-motile spermatozoa. The temperature averaged 22° C. during the tests.

In a consecutive series of fifty inoculations, we have encountered no false positive and only one false negative. This latter may be explained on the basis that the urine sample was abnormally dilute. The series included gonadotrophins, cases of confirmed pregnancy, incomplete abortions, uterine fibroids, secondary amenorrhœa and normal women.

Over a limited series, we have confirmed claims made for this test by Galli Mainini[1], Lima and Pereira[2], who used *Bufo marinus*, and Wiltberger and Miller[3], using *Rana pipiens*. It remains to be seen whether *Bufo bufo* or *Rana temporaria* will be equally suitable.

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Shortage of Scientific Text-Books

As one who is associated with a group of firms dealing with all aspects of the production, publishing and retail selling of learned, scientific and technical books, I have read with very considerable interest the article on the survey of the present shortage of scientific text-books in Cambridge carried out by the Cambridge Branch of the Association of Scientific Workers which appears in *Nature* of August 7, p. 209. Unfortunately some of the conclusions appear invalid.

That there is a shortage of text-books in this category there is no question. Under present conditions it is inevitable that in any discussion of this shortage mention must be made of the Board of Trade, so let me at once pay tribute to the officers of the Board of both the Import Licensing and Raw Materials Divisions, who have been approachable at all times, and, I am convinced, have done their utmost, often in circumstances of considerable difficulty, to ameliorate the position.

That too great a proportion of British scientific text-books has to be exported is a statement difficult to support. Export there is and must be ; but there are few scientific books which are exported to an extent which harms the home market.

With regard to American books, the surveyors appear to be under one serious misapprehension. Despite what they say, it is possible for any individual requiring any American learned, scientific and technical book to go into a bookshop (preferably one with some experience of this type of work) and to order that book. If it is in print in the United States, there is no reason why it should not be in Great Britain within a month of the order being placed.

Secondly, with regard to the 200 per cent quota : this figure, taken in conjunction with the 'single copy' *modus operandi* referred to above, should be adequate to meet requirements at the present time. I agree that it is not so ; but the reason lies not in the 200 per cent total figure but in the allocation of that figure on the basis of individual firms' imports during either the last half of 1939 or the first half of 1940. The reason is quite simple—in ten years the emphasis of business has altered as between firms, both booksellers and publishers, in Great Britain so that the ratio of supply does not fall in the regions where the requirements are greatest.

If the 200 per cent total were to be re-allocated (a difficult but not insuperable task) according to present-day demands, many of the difficulties would be eased and indeed might very well disappear, provided the 'single copy' method of working is used intelligently. This point has been put on more than one occasion to the Board of Trade who, I believe, are shackled by Treasury restrictions.

With regard to the Survey's comments on British books, there is one misunderstanding which should be got rid of immediately : for books in this category paper is no longer a restrictive factor in so far as quantity is concerned. The Board of Trade in conjunction with the Publishers' Association maintain a reserve, known as the Moberly Pool, for 'educational' books : this has been gradually increased as circumstances allow, and it has been administered with the utmost fairness and with the approbation of all concerned. After fairly extensive inquiries, I have yet to find a publisher with a sound case who has been refused an allocation which he required for a book in the categories under discussion. There still are, of course, difficulties with paper in regard to quality and price.

The only other difficulty with material is in regard to cloth. This would appear to be a difficulty not of the basic essentials being unavailable but of the output of the Lancashire mills. Again, both with cloth and with boards there are reasons for complaining of quality and of price.

The production obstacles which any publisher must confront at present are very slowly easing in the field of printing, although a shortage of apprentice entrants as compositors during the war years has caused a bottle-neck which it will take some years to overcome.

In binding books the position is bad indeed. But the lack is not of material, apart from cloth, but of machinery : nearly all of it American. The Board of Trade has been helpful in every way, but the fact must be faced that the source of supply is limited in the beginning, so long as there are so few British types of machines suitable for the work which must be undertaken.

But the main difficulty with regard to all production hold-ups is the shorter working week and the policy which has been psychologically instilled into the minds of so many of the workers that they can expect more pay for less work. This factor cannot be overstressed, and until it is remedied we can expect no real improvement in the supply of scientific text-books.

JOHN GRANT

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MAY I be permitted three comments on Mr. Grant's letter. With regard to his third paragraph, the original article did not suggest that too great a proportion of scientific text-books is being exported. It was stated "that a good case can be made out for the large percentage of book production which goes to export". It was emphasized, however, that this trade and reputation "are in danger unless our total volume of 'learned, scientific and technical' book production is increased, so that both the home and export markets may be better supplied".

On Mr. Grant's fourth paragraph, it was specifically stated in the article that no account was taken of books imported as single copies as this factor was not thought to be important so far as students are concerned. In fact, our experience is that it takes 8–10 weeks to get such books and often longer.

If binding causes great difficulties, have the publishers considered bringing out temporary editions of some of the most needed books in an unbound form similar to *Nature* or *Hansard*. Students to-day could be relied on to treat them with due care.

ROY INNES

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International Exchange of Scientific Information

IN the editorial article in *Nature* of August 14, in criticizing a recent statement of the Atomic Scientists' Association, it is argued that collaboration between scientific men east and west of the 'Iron Curtain' may be undesirable, because it is likely "to promote, for the present, a one-way traffic to the disadvantage of the Western democracies". This view was expressed in the same words on July 14 by the editor of the *Economist*, who, professionally concerned as he must be with economic policy and its effect on foreign affairs, may be excused for including scientific ideas among the commodities available for exchange. But the same view expressed in *Nature* suggests a change in the traditional policy of the journal, which has always stressed the international aspects of science, and it shows strikingly the way in which military considerations can affect the outlook of scientific workers and lead them to adopt against their will a totalitarian view of their function. It is therefore necessary to inquire whether these military considerations really make it necessary to abandon the whole tradition of science, and to break off such contacts as are still possible with the scientific workers of Eastern Europe.

It is stated in the editorial that the man of science in totalitarian countries is essentially a servant of the State, and that it is treason for him to divulge any knowledge save as the State allows. But in fact this statement is true only in the opinions of the men who control the Government of the U.S.S.R.; we may be sure that most scientific men in the satellite countries would not take that view of their functions, and probably many outstanding men in Russia itself hold other views.

Our policy, then, of allowing the free exchange of ideas even across frontiers is one which our scientific colleagues in these countries will feel to be the right policy, and in which we shall have their sympathy. It should not be lightly thrown away through the fear that some small help might be given to their military science.

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THE CORE OF THE INSULIN MOLECULE

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AND
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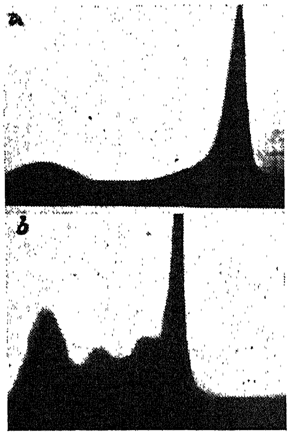
ON account of its stability and well-defined crystalline character, insulin is a favourable point at the present time to attack protein structure. Its composition is probably better known than that of any other protein. The stoichiometrical molecular weight, that is, the least weight into which all the analytical values can be fitted, is 12,000, indicating a comparatively simple character[1]. Recent researches[2] show that the most prevalent molecule in aqueous solution has a molecular weight approximately four times as great, dissociating somewhat in acid and moderately alkaline solutions. The facts, therefore, suggest that the basic unit of insulin is a molecule of molecular weight 12,000. X-ray analysis has indicated that three of these units form the unit cell in crystals[3].

Knowledge of the chemical structure of insulin has been greatly advanced by Sanger[4], by the use of the reagent fluorodinitrobenzene, which reacts with the amino-groups of proteins under very mild conditions, forming a bond which resists acid hydrolysis, so that the amino-acid residues which form the amino-end of the peptide chains can be identified. Sanger has shown in this way that the sub-molecule of insulin consists of four chains, of which two terminate in glycine and two in phenylalanine residues. These chains are presumably held together by the –S–S— links provided by the cystine, of which six exist in the molecule. Sanger has shown that by oxidation with hydrogen peroxide in formic acid solution, according to the method of Toennies and Homiller[5], these disulphide links are oxidized and a product is obtained which has been shown by adsorption analysis[6] and electrophoretic analysis[7] to consist of three or four distinct substances. A fraction was obtained from this which contained no phenylalanyl residues and contained no lysine, arginine, histidine, or threonine, and in which all the terminal residues are glycine[8].

Another line of approach has emerged from the work of Woolley[9], who has found in the partial hydrolysates of various proteins a growth-promoting factor for *L. casei* which he calls 'strepogenin'. Insulin was found to be a particularly rich source of this substance. Strepogenin appears to be a peptide which occurs in insulin at the end of one or more of the chains, since elimination of the free amino-groups of insulin with fluorodinitrobenzene destroys the activity[10]. Woolley has also found that the dinitrophenyl derivative of insulin and of oxidized insulin can be digested by pancreatin. The products have been fractionated by a series of counter-current distributions by the method of Craig[11], and several crystalline dinitrophenyl peptides obtained[12] containing, in addition to dinitrophenyl glycine, the following amino-acids: (1) glutamic acid, (2) glutamic acid, serine, threonine, valine and leucine; (3) same as (2) plus aspartic acid; (4) glutamic acid, serine, tyrosine and leucine; (5) same as (3) plus *iso*leucine and cysteic acid.

A study of the enzyme breakdown of insulin has been made by Butler, Dodds, Phillips and Stephen[13]. It was found that whereas pepsin breaks the insulin molecule into fragments with a molecular weight of *c.* 3,000 and an average chain-length of about seven residues, chymotrypsin removes from the molecule a number of smaller peptides of molecular weight *c.* 800, leaving a more massive residue which is precipitable in $0 \cdot 25\ N$ trichloroacetic acid. After extracting the trichloroacetic acid with ether, it was found that its molecular weight is 4,000 ± 1,500. In two separate experiments, it was found to contain between 80 and 90 per cent of the total amount of cystine of the insulin molecule. It thus appears that the result of chymotrypsin digestion is to remove parts from the ends of the insulin chains, leaving a 'core' in which the chains are united by –S–S– links. This core is slowly broken down by the long-continued action of chymotrypsin.

Attempts made to separate the smaller peptides in the trichloroacetic filtrate have on the whole been unsuccessful. Paper chromatography with phenol divided them into four broad bands[14]; but it has been found that this is at best only a partial separation, since eluting the bands separately and repeating the process gives a very similar pattern. Paper chromatography with butyl alcohol – acetic acid as solvent has given a series of fifteen distinct spots, most of which are peptides; but it has not so far been possible to isolate these substances in sufficient quantity for examination.



(*a*) Electrophoretic diagram of the core material (C11*B*) at *p*H 8·0.
(*b*) Electrophoretic diagram of the oxidized core (C11*B*) at *p*H 7·0.
Experiments by Dr. J. M. Creeth. Ascending boundaries shown.

Further examination of the material precipitated by trichloroacetic acid has provided evidence of its essential homogeneity. It gives a single sharp boundary in electrophoresis (Fig. *a*). Dr. K. O. Pedersen, of the Institute of Physical Chemistry, Uppsala, has kindly determined its diffusion coefficient by the free diffusion method[15], obtaining the figures $D_A = 18 \cdot 6 \times 10^{-7}$, $D_M = 18 \cdot 3 \times 10^{-7}$ at 20°. This corresponds to a molecular weight, assuming a spherical and unhydrated molecule, of approximately 5,000. All the amino-acids of insulin are present, except possibly arginine, threonine, proline and phenylalanine, which have either been absent or shown up weakly in one of the fractions resulting from oxidation of the core.

After oxidation by hydrogen peroxide in formic acid solution, the product shows four well-defined peaks in the electrophoresis diagram (Fig. *b*). The slowest of these (left-hand peak in the diagram) may be due solely to the δ-anomaly, since this material cannot be equilibrated with the buffer by dialysis. Their isoelectric points are below pH3, indicating the presence of strongly acid groups, as may be expected from the presence of cysteic acid. When the oxidized material is taken in aqueous solution to pH 4·5, a small fraction corresponding to Sanger's fraction B, but containing only 5 per cent of the material, separated. This could be shown to contain *all* the amino-acids of insulin, that is, those present in small amounts and undetectable in the whole core are concentrated in this fraction. The remainder lacks arginine, proline, lysine, threonine and phenylalanine. It is possible that the small separated fraction is a small amount of material, carried along by the core but not really belonging to it, or to a portion of core not broken down as much as the remainder. The oxidized soluble substance was also found to be complex by paper chromatography in butyl alcohol–acetic acid mixtures and showed three or four separate spots with ninhydrin.

The core can also be converted into its dinitrophenyl derivative by Sanger's method. The product, when examined by paper chromatography with phenol, gives two distinct yellow spots, a main spot and a fainter one, and is therefore apparently not completely homogeneous. Different digests behaved differently in the relative intensities of these spots, and it is probable that the core is more digested away in some cases than in others. After hydrolysis with 6N hydrochloric acid, the dinitrophenyl core was found (in one experiment) to yield the following amounts of dinitrophenyl amino-acids, calculated for a core molecular weight of 5,000: glycine, 2·5 molecules; with smaller quantities of valine (0·4 molecule), terminal histidine (0·8 molecule) and ε-lysine (0·5 molecule). This core was 40 per cent of the insulin molecule. Another core (36 per cent) gave glycine, 2·4 mol.; valine, 0·3 mol.; histidine, 1·7 mol. The glycine figures involve a considerable correction for the decomposition of dinitrophenyl glycine during the hydrolysis and may require revision. The fractional numbers and the variation of different cores would suggest that the core molecules are not all of the same kind.

After oxidation of the dinitrophenyl derivative, the product is divisible into two portions: (1) soluble in water, (2) insoluble in water. It has been found that the soluble portion can be separated into three bands, the first rather diffuse and the other two sharp, by passing its aqueous solution down a starch column. The insoluble fraction can be made soluble by dissolving in dilute ammonia. After neutralizing with acetic acid, it also gives three bands similar to those of the original soluble portion. Since a mixture of the soluble and insoluble parts when dissolved together also gives the three bands, it is concluded that the original soluble and insoluble portions are either made up of the same or of closely related substances. The proportions seem, however, to be different. Work on characterizing these fractions is being continued.

We have frequently observed in our work on the digestion products of insulin that a preparation became insoluble after thorough drying, and that treatment with dilute acid or alkali was necessary to bring it into solution. The removal of water apparently causes loose bonds to be established between the peptide chains, possibly through the interaction of neighbouring acidic and basic groups to form an insoluble complex, which is only broken by the application of acids or alkalis.

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BIREFRINGENCE AND ORIENTATION-RATE OF THE LEPTONES OF PROTOPLASM

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PRESENT knowledge indicates that the submicroscopic or 'leptonic' state of organised gels[1] consists of a framework of reciprocally associated macromolecules or molecular bundles (micelles). Their orientation-rate within the gels, as observed in polarized light, decides whether there are formed anisotropic gels in which the particles (leptones) are arranged parallel to each other, or isotropic gels in consequence of perfect disorientation of the leptones. Between these two limiting cases, there are many textures with differently graded orientation-rates. If a system contains imperfectly oriented leptones, the orientation-rate, and hence the birefringence, will be increased by tension[2]. Thus the birefringence will reach a maximum when the leptones are maximally oriented. But the theoretical relation between birefringence and orientation-rate is somewhat indefinite, for even in the case of perfect orientation the rate of grid-like disposition cannot be comprehended apart from the remainder. Moreover, isotropy includes cases of perfect disorientation as well as adjacent organisation in the immediate environs (*Nahordnung*). Further complications in consequence of different rates of swelling and extension cannot be taken into consideration here. The distribution function of O. Kratky, P. H. Hermans and coworkers[3], defining the frequent repetition of the different directions of leptones, has been obtained from the extension-rate of the gels and their orientation state *before* the extension. But with biogels, the deformation-rate during the unextended, that is, isotropic, state is not appreciable. Frey-Wyssling[3] has derived expressions describing the field or cone of scattering of leptones by means of a single angle. This method, however, gives only a comparative measure of the increase of orientation. I have now been able to investigate the *streaming birefringence* of protoplasm and to calculate the orientation-rate of its leptones.

By means of much improved experimental arrangement, it has been shown that protoplasm sucked up into a capillary becomes doubly refractive if it is made to flow by a compressing force[3]. Continuing these experiments[4], the birefringence has been found to be negative with regard to the flow direction. Hence, evidence is available that the effect first described by Pfeiffer is produced by lipids of the protoplasm. The interpretation of the experiment is perhaps doubtful, and we do not know whether, by sucking up the material, the protein chains are straightened out and the lipids have to follow the orientation, or whether the lipids, by the interlocking, are released and become able to arrange themselves parallel with one another. But the flow experiment with protoplasm makes it possible to evaluate the *maximal* streaming birefringence, and hence a given orientation-rate, and to make other measurements (for example, length of leptones, to be described shortly elsewhere).

For the quantitative study of the birefringence of protoplasm flowing within a capillary, the latter has been embedded in a liquid of the same index of refraction as the protoplasm[5] (about 5 mm.^{3} of the *Physarum polycephalum* plasmodium grown on oat agar). A detailed description of the apparatus and the method of stimulating the flow have been published already. The quantitative studies relate to the character (sign) and the phase difference (intensity) of the anisotropy of protoplasm, and to its direction of extinction. If, as with protoplasm, long-chain molecules are not oriented at 45° to the gradient of flow, but at angles between 45 and 90°, it is necessary to define the direction or *angle of extinction*, χ (*Auslöschwinkel*, angle of isocline, *Kreuzwinkel*). For this purpose we find the orthogonal position of the crossed nicols in a lateral, extinguished flame of the capillary[6]. The flow capillary is fixed and the optical polarizing equipment adjusted as a whole; then the angle required results from the extent of the turning movement against the direction referred to. The *negative sign of anisotropy* results from the use of a Red I (gypsum) plate oriented, like the object, with its direction of fast and slow transmission at 45° to the planes of polarizer and analyser, and, as usually employed, the slower vibration direction (larger index) extending from the upper right to the lower left quadrant of the field of view. The *phase difference* of the object (Γ) has been measured with a very sensitive Brace compensator (rotating $\lambda/30$-mica compensator) and the half-shadow wedge according to Macé de Lépinay at varying velocities of flow[7]. The polarizer is set at 0°, the object brought into focus and oriented in a diagonal position (45° to the polarizer plane), and the compensator and the analyser are inserted (nicols crossed). After the compensator has been adjusted so that the field surrounding the object is maximally dark and the angle noted (average of five to ten readings), the compensator is then moved round so that the object is maximally dark (five to ten readings again). If the difference between the two series of readings is β, then the retardation is $\Gamma = (\lambda/30) \sin 2\beta$, and the birefringence, as usual, $\Delta n = \Gamma/d$, where d is the thickness of the preparation.

In regard to the rate of orientation, it is necessary to mention especially the *extinction angle*, χ. As usual, it increases with the flow gradient and the viscosity, and decreases as the temperature goes up; but above all, it depends upon the length of the leptones. The extinction angle has been found to have values between 61° and 76°. For each series of experiments with successively increased shearing forces, the angle shows a constant value over the period during which the preparation could be kept free from denaturation. For smaller flow velocities smaller values of χ are found, which, however, are well reproducible and do not show any ageing effects. Sometimes the measured values show more scatter than could be expected from an estimation of the usual experimental errors. Hence this scattering must be due to variations in the origin and nature or special character of the material. If the same measurements are taken by varying the λ (using a cadmium spectral lamp or a perfect monochromator), with other conditions constant, a similar set of characteristic curves is obtained.

The movability of the protoplasmic leptones is measured, according to Boeder[8], by the *rotation diffusion constant*, D_R. The quotient of the gradient of flow dv/dn and of D_R represents the parameter α, which is related to a precise *direction density* ρ. If α is increasing, the maximum of the accumulation is displaced to higher χ-values. The gradual transition from lower to higher χ-values, depending on the decreasing gradient dv/dn, takes place, of course, the earlier the lower D_R is obtained. Using only one measurement of χ at a known gradient dv/dn, the constant D_R and the parameter α are, theoretically, measurable with protoplasm double refractive by flowing.

By measuring the *phase difference* Γ at an extinction angle χ sufficiently far from 45°, we are able to calculate the *maximal birefringence*, that is, the double refraction in case of orientation of all the leptones. With regard to the coefficient μ, with which we have to multiply the measured phase difference, in order to obtain the saturation value of birefringence, we find:

χ	50	55	60	62½	65	67½	70	72½	75	77½	80	85
$\Delta n_{\text{obs.}}/\Delta n_{\text{max.}}$	0·09	0·15	0·23	0·28	0·35	0·40	0·44	0·48	0·51	0·54	0·56	0·61
μ	11·1	6·7	4·3	3·5	2·9	2·5	2·3	2·1	1·9	1·8	1·7	1·6

We have, however, to accept the limitation to the *plane* problem; the three-dimensional problem does not seem to be capable of solution with our present knowledge. With this restriction, only a limited number of leptones become arranged parallel with the direction of flow; calculation indicates 20–30 per cent, and for very long chain molecules only 3–5 per cent. Further complications are to be expected if the leptones should be deformed by the flow[10].

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CARNEGIE INSTITUTION OF WASHINGTON

THE feature of most general interest in Dr. Vannebar Bush's report as president of the Carnegie Institution of Washington for the year ended October 31, 1947 (Year Book No. 46), is his review of the range of the Institution's activities, and particularly the relation of the Institution to Federal support. Dr. Bush points out that the Institution has always recognized that research stands or falls by the men who are responsible for its prosecution, and from its earliest days has consistently sought the exceptional man and provided him with facilities and resources to pursue problems which he discerned and by his own methods. Latterly, in establishing its own research centres, the Institution has recognized that such centres are of ultimate value in the search for knowledge only as they are utilized by groups of investigators including leaders of proved skill and acumen and younger men of real promise. Dr. Bush pays a high tribute both to the creative work of the Institution's scientific staff, and is also satisfied with the general plan of organisation of the work and with the effectiveness of its administration. Discussing next the termination at the end of the War as expeditiously as possible of all research for the Government, to enable the Institution to return to its own programmes of fundamental research and its policy of free dissemination of results, he considers the policy of the Institution of not seeking broad support for its research from federal funds in the light of the increasing support of fundamental investigation from Government funds.

Dr. Bush considers that the policy governing grants by the National Government for fundamental research has so far been characterized by vision and wisdom, and that it is highly important the federal policy should continue. Acceptance by the Carnegie Institution of such funds for enlarging its research programmes should depend first, however, on any such research activity forming as nearly as possible an integral operative and administrative unit, or that the activity can be terminated easily if the support terminates. The activity should, moreover, be one both intrinsically worth while and a natural addition to the Institution's own regular programme. It should also be one to which the Institution can genuinely contribute by reason of the skills and operations of the regular staff and the presence of the regular programme. Finally, the conditions under which the Institution accepts such funds should in no way infringe the independent status of the Institution in pursuing its own regular programme of research, and they should be genuinely adapted to the prosecution of fundamental investigation of the highest quality.

In reviewing the research activities of the past year, Dr. Bush notes that 1946–47 was the first since 1940 in which all departments and divisions had been fully engaged on normal programmes. Continuing his investigation at Mount Wilson Observatory of the general magnetic fields of stars, Dr. H. Babcock has surveyed likely stars down to the sixth magnitude, finding magnetic fields stronger than 1,000 gauss in several and a polar field of 5,500 gauss in one. At the Geophysical Laboratory, the development of a new type of pressure apparatus has facilitated the study of equilibrium relations in hydrous mixtures. In the magnesia – silica – water system, all the commoner natural hydrous silicates of magnesia, as well as two anhydrous silicates, could be prepared with only the solid phases and vapour present. Equilibria up to 900° C. at pressures up to 15,000 lb. per square inch and at 800° C. up to 30,000 lb. have been determined. New procedures developed in the Department of Terrestrial Magnetism have indicated that, within the accuracy of the measurement, the strength of the magnetic field of the earth has not changed during the past 30,000 years. A large increase in the intensity of cosmic radiation at all observing points except at the equator was observed at the time of a marked solar flare and radio blackout on July 25, 1946.

Extensive study of a wide variety of plants in the Division of Plant Biology indicates that the chloroplast pigments essential in the photosynthetic apparatus of all plants have changed but little in the evolution both of the species in major taxonomic groups and of the main groups themselves. The active pigments of present-day green algæ are thus the same as those possessed by their fossil ancestors, and results obtained in the further study of the unicellular alga *Chlorella* have shown that while the chemical composition of the alga varies widely with the culture conditions selected for its growth, the nature of the chlorophyll pigments is unchanged. The grass-breeding programme of the Division of Plant Biology undertaken in co-operation with the Soil Conservation Service of the United States Department of Agriculture has yielded hybrids of high promise owing to their combination of favourable yield, resistance to disease and continued activity in dry summer weather. The species used in the crossings produce most of their seed asexually but, unexpectedly, it was found that two-thirds of the hybrids between asexual parents were themselves sexual.

The aerosol method developed in the Department of Genetics for investigations involving the treatment of *Drosophila* with chemical solutions has been used for testing the power of various carcinogenic agents to effect mutations in genes. Most of the carcinogens thus tested were mutagenic, and most substances related chemically to the carcinogens but not themselves carcinogenic did not produce mutations. Dr. Dobzhansky's work in the same Department has shown that the proportion of certain types of *Drosophila* in wild populations changes with the season. The fly thus shows substantially the same kind of differentiation into altitudinal races as Drs. J. Clausen, D. D. Keck and W. M. Hiesey, of the Division of Plant Biology, found for species of *Achillea*.

In the Department of Embryology, Dr. L. B. Flexner and his colleagues, using radioactive sodium and heavy water, have obtained further evidence that the ratio of water within the cells of newborn infants to extracellular water increases as growth proceeds, and further studies of the permeability of the placenta are being pursued. Dr. S. R. M. Reynolds is investigating the physical forces involved as the uterus accommodates itself to its growing contents, as a contribution to the fuller understanding of the problems of advanced pregnancy and of parturition.

More detailed accounts of the investigations in progress or completed during the year are to be found in the departmental and divisional reports which follow that of the president, and to which bibliographies are appended. From this it is only possible to select a few further investigations for mention, such as the attention being given by the Geophysical Laboratory to thermal measurement and to studies on radioactivity, and by the Department of Terrestrial Magnetism to studies of the earth's crust and of the upper atmosphere as well as to cosmic ray research. A feature of this report is the review of the magnetic survey and observatory programme of the Department over the period 1904–46. In the Division of Plant Biology, investigations on the chemistry of chlorophyll formation have been extended to include analysis of the process at different temperatures, and in that of Embryology tests have been made of the action of a large series of dyes related to Nile Blue on tumours in mice. Full accounts of work on the organisation of the chromosome, of cryptogenetic studies of maize and *Neurospora*, of chromosome studies on gall midges, and of work on mouse leukæmia and on the genetic structure of natural populations are included in a long report from the Department of Genetics, while that from the Division of Historical Research deals with the results of the expedition to Bonampak, in Chiapas, Mexico, the field work in the Guatemala highlands and the preparation of a hand-book of ceramic technology for archæologists and a preliminary analysis of Usulatan ware.

INTERNATIONAL COMMITTEE FOR BIRD PRESERVATION

A MEETING of the European Continental Section of the International Committee for Bird Preservation held in Paris during July 17–20, under the chairmanship of Dr. Boje Benzon, was attended by representatives of Austria, Belgium, Denmark, France, Great Britain, Hungary, Italy, Netherlands, Norway, Sweden and Switzerland; though the German National Section has not yet been reorganised, the interests of that country were represented by the chief game warden of the British Zone accompanied by a German adviser and by a German adviser from the American Zone. The president of the Zoology Section, International Union of Biological Sciences, and an observer from the Natural Sciences Section of Unesco attended, and the Conseil International de la Chasse was also represented.

The chief business of the Conference was the discussion of proposals for the revision of the Paris Convention of 1902 for the Protection of Birds Useful to Agriculture, on which the International Committee for Bird Preservation commenced work thirteen years ago. In 1935 representatives of the Finnish, Norwegian and Swedish Governments drew up a Draft Convention for the International Protection of Birds which was presented at a Conference of the International Committee for Bird Preservation held in Brussels that year. After due consideration it was decided at this Conference that an entirely new Convention was not practicable and that proposals for the revision of the Paris Convention of 1902 should be put forward. Lord Justice von Seth (Sweden), on behalf of the Scandinavian countries, accepted this suggestion with the proviso that the broad outlines of the Scandinavian proposals should be maintained. The matter was then referred to an International Sub-Committee consisting of M. A. Chappellier (France), (the late) Dr. Percy Lowe (Great Britain), Prof. M. Siedlecki (Poland) and Lord Justice von Seth (Sweden), with Miss Phyllis Barclay-Smith (Great Britain) and M. Leon Lippens (Belgium) as secretaries. Each national section in Europe was then requested to send to the secretariat suggestions relating to the modification of the Paris Convention. The Sub-Committee, taking into consideration the views of all countries, drew up these suggestions into a general report to serve as a basis for the discussion of a definite final proposal.

The report of the Sub-Committee was discussed at a conference in Vienna in 1937, attended by representatives of twelve European national sections, and proposals for a revision of the Paris Convention agreed. The necessary diplomatic steps to bring these proposals to the attention of the Governments concerned were in progress on the outbreak of war.

However, at a conference held in London in June 1947, attended by representatives of fourteen European national sections, it was decided that in view of the many changed circumstances during ten years, the Vienna proposals were in need of further revision. The matter was again referred to an International Sub-Committee consisting of Dr. Boje Benzon (Denmark), M. G. Olivier (France), Mr. R. A. H. Coombes (Great Britain) and Dr. J. H. Westermann (Netherlands), with Miss Barclay-Smith and M. Lippens as secretaries as before. This Sub-Committee met in Brussels in November 1947 and drew up recommendations which were forwarded to all the national sections of Europe for their comments before being discussed at the Paris Conference in July 1948.

The proposals for the revision of the Paris Convention, 1902, agreed upon at this Conference meet not only the changed conditions and circumstances but also the change in outlook during the course of nearly fifty years. Whereas the Paris Convention was designed to afford protection to birds useful to agriculture (with emphasis on the small insectivorous birds), the scientific, educational and æsthetic aspect of bird life is now recognized, and in point of fact, at the present day, the larger birds are in need of as much, if not more, protection than the small insectivores. Therefore, the fundamental basis of the present proposals is that all birds should have some measure of protection. Far more is known about migration than was the case in 1902, and the countries are becoming more and more aware of their interdependence and obligations towards each other in this matter; it is now appreciated that it is not possible for the country in which migratory birds breed to maintain the stock unaided. The broad outlines of protection now proposed are that birds should be protected during their breeding season and, so far as migratory species are concerned, during the times of their *return* to their nesting grounds; also that birds in danger of extinction should have special protection. Allowance for exceptions is made when and where necessary in the interests of agriculture, forestry, fishing, science, education, etc., and for the special economic conditions in certain regions. It is also realized that the all-important balance of Nature should be maintained in every way possible, and that any bird which may constitute a menace to other species must be kept in check. The sentimental idea of a 'sanctuary' for all species where everything is inviolate is, in fact, no sanctuary, and there have been far too many instances of this: to take one example, tern colonies have almost disappeared under the onslaught of gulls, to whom an all-embracing 'protection' has afforded an undue advantage.

Import, export, transport, selling or buying are also dealt with in regard to species taken illegally, and eggs are considered equally with the birds themselves.

Certain methods for the mass capture or destruction of birds are condemned. This is a particularly difficult subject owing to old-established customs and widely diverging points of view and national temperaments. What is regarded as a normal state of affairs in one country may be deplored by its neighbour, and it is not easy to arrive at a general agreement, a tolerant give and take and gradual change being the only solution.

A point which was of no great importance in 1902, but which has become of vital importance in 1948, is the safeguarding of habitat which is the fundamental for the existence of any species of bird; with the rapid spread of civilization this is becoming more and more serious so far as all forms of wild life are concerned.

In addition to the Convention another important question dealt with by the Paris Conference was the International Inquiry into the status of the Anatidæ in Europe, and the progress being made in the various countries regarding this. The British Section, which has been allocated the task of correlating the information sent in from all over Europe, presented a report on the arrangements being made to carry out this work.

Other matters discussed were the conditions of transport of birds by air, a biological station on the Neusiedlersee in Austria, and the publication of the second edition of an International Ornithological Dictionary by Denmark.

The membership of the International Committee now numbers thirty-five, Iceland having been the latest country to form a national section. The headquarters are at the British Museum (Natural History), London, with further secretariats in Brussels and New York.

BIOLUMINESCENCE

THE increasing use of the fluorescent lamp in recent years has served as a stimulus to the study of the mechanism of the emission of cold light; and this in turn has led to a renewed interest in the production and utilization of such light in luminous animals. The Section of Biology of the New York Academy of Sciences held a Conference on Bioluminescence in November, 1946, and the papers submitted, which have now been published*, provide a comprehensive review of the subject.

In a general survey, E. Newton Harvey points out that about forty different orders of plants and animals, ranging from bacteria to fish, contain self-luminous species. A few of these, such as the fish *Photoblepharon* and *Anomalops*, make use of luminous bacteria housed in special pouches which can be covered or exposed at will by a sort of eyelid. Chemiluminescence in general is reviewed by R. S. Anderson. Colour, fluorescence and chemiluminescence are probably degrees in an analogous process. Emission results from the loss of a quantum of energy during the change from an excited electronic state to a ground-state with less energy, these changes being independent of high temperature. Only in comparatively recent years, with the discovery of the bright chemiluminescence of aminophthalhydrazide and dimethylbiacridinium nitrate, have systems been obtained which can rival in luminosity the substances extracted from living organisms. It was in 1886 that Dubois first demonstrated that light production in animals results from the interaction of luciferin and the enzyme luciferase. In the Ostracod *Cypridina* these two components are discharged in the form of granules from separate glandular pores and then interact in the sea water. This animal, therefore, affords ideal material for the study of these substances *in vitro*, and the recent work in this field is reviewed by A. M. Chase. The structure of luciferin has not been fully elucidated; but there is evidence that it has a relatively small molecular weight and contains a hydroxybenzene structure which is reversibly oxidized to a quinone. F. H. Johnson and H. Eyring discuss the action of pressure, temperature and drugs on the enzymes concerned in bacterial luminescence.

By far the longest paper is by J. B. Buck, who provides a comprehensive review of the anatomy and physiology of the light organ of fireflies and contributes some new suggestions on the control of light emission. There is the utmost diversity in the anatomy of the light organ in the beetles; their histology ranges in complexity from a group of loose independent giant cells, apparently without tracheæ, similar to, and perhaps identical with, the œnocytes (such as occur in *Phengodes*), to the highly complicated arrangement in *Photinus* or *Luciola* where a reflective layer containing urate granules underlies the photogenic layer. In the most complex type a rich supply of tracheæ runs vertically through the reflective layer and then enters specialized cylindrical rods of tissue which pass straight through the photogenic layer. Here they give off lateral branches which end in conspicuous tracheal end-cells by breaking up into the tracheoles which supply the photogenic cells. Buck is satisfied that the tracheoles do not enter the cells; but there is evidence that they are connected together by an ultra-tracheolar network which may, perhaps, consist of open tubes.

It is this very highly evolved system which provides some of the most intriguing problems in the physiological control of luminescence. Light may be emitted as a steady glow or in the form of brilliant flashes showing a remarkable periodicity which is under the control of the organism. It is the control of flashing which has excited most controversy. There is no doubt that the organ is supplied by nerves which stimulate it to activity. It is equally sure that the production of light is dependent upon the access of oxygen to the photogenic cells. Argument has centred around the question whether the cells are stimulated directly to produce light—perhaps by the dissolution of barriers which normally separate the enzyme from its substrate—or whether the nerves control the access of oxygen. It is well known that the endings of the tracheoles in many insects contain liquid which may be absorbed into the tissues during activity and so replaced by air. It has been suggested that the enhanced oxygen supply which then results may be the cause of the light flash; but, as Buck points out, if this change does occur in the tracheoles of the luminous organ it is more likely to be secondary to the metabolic activity of the cells. The tracheal end-cells, an enlarged form of the cells which occur in many insects where the tracheæ break up into tracheoles, are a characteristic feature of the flashing type of organ. It has often been suggested that they

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[1] *Annals of the New York Academy of Sciences*, 49, 327 (1948).

play some part in the process. Dahlgren described what appeared to be a sphincter around the tracheole at this point, and beyond it a structure with radiating fibres. Buck outlines a reasoned hypothesis according to which the glowing of the organ is dependent on the diffusion of oxygen into the tracheoles, while the flashes are due to the mechanical projection of 'jets' of air into the tracheole by the controlled relaxation and contraction of the sphincter mechanism in the tracheal end-cell. But he concludes that the evidence at present available is insufficient to decide between this hypothesis and that of direct nervous stimulation of enzymic activity in the photogenic cells.

V. B. WIGGLESWORTH

SYMPOSIUM ON SEARCHLIGHTS

ONE of the most important features of a scientific society is its capacity to arrange a symposium on a special feature of its activities and to publish the resultant papers. There are many subjects where the interested people are too few for the probable financial return to tempt an author to the publication of a book, and where in addition the knowledge is so specialized that no one author can easily do justice to it. The publication under review* is such, and the Illuminating Engineering Society deserves the thanks of those who, either as user or manufacturer, need to know about searchlights in some detail. The scope of the book is indicated by the sectional headings: "The Function and Design of Army Searchlights", by E. W. Chivers and D. E. H. Jones; "High-power Searchlights of Wide Divergence", by Air Commodore W. Helmore, H. K. Cameron, F. S. Hawkins, L. B. W. Jolley and L. M. King-Brewster; "Photometry of Searchlights", by H. K. Cameron, E. H. Rayner, E. R. Thomas and G. T. Winch; "The Visibility of Targets in a Naval Searchlight Beam", by W. D. Chesterman and W. S. Stiles; "Some Visibility Problems Associated with Anti-Aircraft Searchlight Beams", by S. S. Beggs and J. M. Waldram; "Aircraft Searchlights for Anti-Submarine Warfare", by Commander C. J. Carr.

There are, in addition, some twelve pages of discussion.

The meeting was held in London on April 15, 1947, and presumably the difficulties of post-war publication are responsible for the delay in the appearance of the book.

As the titles suggest, there is a marked war-time flavour about the publication, although some of the work was carried out before 1940 but has not previously been made available to the scientific public. The balance between the historical background of searchlight design, theory and photometry, and the immediate foreground of practical war-time development has been well maintained, and the result is a record which will find a place in many industrial and technical libraries.

It may come as a surprise to many that an increase in intensity of a searchlight from 100 megacandles to 500 megacandles only increases the range by some 50 per cent in clear weather and by only some 15 per cent in medium weather. One may therefore be allowed to wonder whether the effort put into the development of the larger sizes of searchlight was justified, especially as it meant the complication of additional spare parts.

Probably the part which will attract most attention is the description of the design and manufacture of high-powered projectors for such special purposes as the interception of night-flying aircraft and submarines lying on the surface of the sea. The 'Turbinlite'—to use the war-time code word—as finally designed consumed 140 kw. with a 90-cm. mirror and was supplied by batteries which could operate for four periods of 30 sec. The whole was carried in the nose of an aeroplane, and the success of the scheme was demonstrated on many occasions. Figures are also quoted for the 'Leigh Light'—used against submarines—showing that the number of U-boats seen was increased sevenfold by its use and that 11 per cent of all night attacks carried out by its use resulted in 'kills'. The specialist in photometry will find summaries of considerable value, of both theory and practice as applied to these mammoths of the illuminating engineer's industry, much of it available in convenient form for the first time. In the case of 'visibility', many of the problems only became urgent under the stress of enemy action. Some of the solutions are especially neat, such as the 'perspective' explanation by Beggs and Waldram of the case of the apparent sudden ending of a searchlight beam to an observer near the projector.

There are a number of errors and misprints which may cause difficulty, as, for example, p. 44, Fig. 17(*b*). The symbols θ and ψ appear to be interchanged. P. 45, third line, this expression has been disarranged in the printing. P. 133, in the formula the symbol φ has been omitted after K in the square brackets.

The book provides in a convenient form a technical treatise on its subject and, in addition, a record of war-time achievement of which the various authors have reason to be proud. The diagrams and pictures are clearly and well produced; but an index would have increased the reader's pleasure and the utility of the production.

W. M. HAMPTON

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* Searchlights. A series of five papers, with the discussion on those papers and a further written contribution. Pp. 164. (London: Illuminating Engineering Society, 1948.) 17*s*. 6*d*. net.

AFFORESTATION FOR BENGAL

ANYONE who has travelled by railway throughout India must have noticed the disparity reigning in the distribution of the forests in that country. In some parts the railways pass through great and apparently interminable tracts of forest and jungle. In others, of which Bengal forms one of the best of examples, the converse is the case. Between Calcutta and the foot of the Darjeeling Hills the traveller by railway passes over a great plain devoted mainly to the production of rice, the villages mostly in groves of palm trees, but a total absence of forest. The forest part in Bengal represents only 0·07 acre per head of population. Bengal has only 9 per cent of its surface under forest, and a considerable part of the latter is in the Darjeeling Hills and the Sundarbans south of Calcutta.

Modern conditions and demands resulting from the Second World War, to some extent, and the great necessity to improve the agricultural soils of the Province, have at length roused the authorities. These soils are not manured. The large quantities of cow dung obtained from the great herds of cattle kept by the villagers are at present, and have been for many centuries past, utilized as fuel for heating and cooking purposes. One of the objects of the projected afforestation plan for Bengal is to create plantations suitably distributed to provide fuel for these purposes and thus release the manure for its proper use. A Bill for the purpose of afforesting of waste lands and for conserving what is left of private forests was introduced in the Bengal Assembly in 1944. The Bill was enacted in April 1945, and already considerable progress has been made so far as private forests are concerned.

Here we have somewhat similar provisions to the Dedication of Woodlands scheme in Britain (*Nature*, Sept. 4, p. 364). The Bengal Government has the power and the duty of telling the owner how to use his forests, and the Government will meet all expenditure for the first ten years, and in certain cases and conditions the Government may make loans to private owners. As regards the waste land, the estimated area which should be, and could be, afforested is four million acres or 9 per cent of the area of the Province. If this area was afforested Bengal would then have no less than 18 per cent of its lands under forests. Much of this area, it is said is, above the paddy fields and is of a highland nature. It is said to have been under forest once, but with the forest removed soil deterioration, leaching and erosion resulted. Yet the land is believed to be afforestable. It is a big scheme and one which will make high demands on the forest staff of the Province in all its ranks.

In the paper read by Mr. T. M. Coffey, chief conservator of forests, before the members of the Rotary Club, Calcutta, in 1947 (reprinted in *The Indian Forester*, **73**, No. 11; November 1947), it is said that to carry out the programme will require to have a forest officer in every district in the Province. At present there are ten districts with forest officers and seventeen without. There can be little doubt that this is a thoroughly sound scheme—but it will require pluck, perseverance and drive and continuity in management and working to see its successful completion. If this is fully recognized, enormous benefits will be conferred upon future populations in the Province. E. P. STEBBING

THE B.B.C. QUARTERLY

IN April 1946 the British Broadcasting Corporation inaugurated a new periodical entitled *The B.B.C. Quarterly*, which was intended for those in Great Britain and abroad who are interested, professionally or otherwise, in broadcasting and its organisation. During the past two years the successive issues of this journal have contained articles on a wide variety of subjects connected directly or otherwise with the purpose of broadcasting and its administration, and with the technical and radio engineering developments which are necessary for the ever-increasing needs of modern broadcasting, including its international aspects.

More than half the contents of the first number of the third volume, issued in April, comprises a series of articles by specialists introduced and edited by Sir Arthur Salter under the general title of "The Impact of Broadcasting on Great Britain's Life and Outlook—I". The remainder of the issue consists of three articles dealing with some present-time activities of the engineering sections of the B.B.C.

In the first article, Messrs. H. B. Rantzen and J. H. Holmes describe the proposed developments which are now being undertaken to provide adequate communication facilities, mainly telephone and teleprinter, over the whole network interconnecting London and the regional broadcasting centres in Great Britain. Following this, Mr. L. Hotine gives an interesting, illustrated account of the engineering arrangements which were made for broadcasting the Royal Wedding. On this occasion, commentaries and eye-witness accounts of the processions and marriage ceremony were made in forty-two languages for the B.B.C. Home, European and Overseas Services. Provision was also made for such accounts to be given to more than fifty stations and networks in the Dominions and Colonies, and for similar facilities to be provided for the big networks and independent stations in the United States and in various European countries. Certain limited television programmes were also provided; and the success of all these arrangements is a tribute to the efficiency of all those concerned with this phase of the operation of outside broadcasting technique.

The third article deals with a subject of great and increasing importance in modern broadcasting: the suppression of unwanted radiation from medium-wave transmitters. Mr. J. B. Webb describes the manner in which spurious radiations from transmitters can, by harmonics or combination frequencies, cause interference with other broadcasting services. This possibility has become more serious in recent years, due to the increase in both the number and power of stations in operation in the medium wave band. The identification and attenuation of existing spurious radiations is often expensive and complicated, requiring the use of widespread technical facilities. But it is very clear that careful consideration should be given to possible unwanted radiations before a new service is introduced, or an increase in power contemplated at an existing installation.

FORTHCOMING EVENTS

Saturday, September 11

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, DIVISION FOR SOCIAL AND INTERNATIONAL RELATIONS OF SCIENCE (at the Dome, Brighton), at 7.30 p.m.—Discussion on "Science Across the Frontiers". (Dr. Julian Huxley, F.R.S.: Introduction; Dr. Joseph Needham, F.R.S.: "Origins and Development of the Organisation of International Scientific Co-operation"; Prof. Pierre Auger: "Present Scientific Activities and Programme of UNESCO"; Dr. Paulo Carneiro: "The International Research Institute of the Hylean Amazon").

Sunday, September 12

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (at the Dome, Brighton), at 8 p.m.—Rt. Hon. Viscount Samuel, P.C.: "Science and Philosophy".

Monday, September 13

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (at the Royal Pavilion, Brighton), at 8 p.m.—Prof. J. D. Bernal, F.R.S.: "Waves and Beaches".

Monday, September 13—Tuesday, September 14

SOCIETY FOR GENERAL MICROBIOLOGY (at the University, St. Andrews).—Scientific Papers.

Monday, September 13—Friday, September 17

HORTICULTURAL EDUCATION ASSOCIATION (at Edinburgh).—Autumn Conference.

Wednesday, September 15

ROYAL INSTITUTE OF CHEMISTRY (at Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—Dr. A. J. Turner: "Research on Linen".

Thursday, September 16

Royal Anthropological Institute (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Prof. C. von Fürer-Haimendorf: "Wealth and War among Two Himalayan Tribes".

Friday, September 17

Society of Leather Trades' Chemists (in the New Chemistry Building, The University, Leeds), at 2 p.m.—Mr. G. S. Adair, F.R.S.: "Recent Work on Osmotic Pressures, Membrane Equilibria and Solubility Factors of Proteins in the Light of the Work of Procter" (Third Procter Memorial Lecture).

Royal Institute of Chemistry, Newcastle-upon-Tyne and North-East Coast Section (in the Chemistry Department, King's College, Newcastle-upon-Tyne), at 3 p.m.—Symposium on "Polarography and Infra-Red Spectroscopy".

Friday, September 17—Monday, September 20

Association of Special Libraries and Information Bureaux (at Ashorne Hill, Leamington Spa).—23rd Annual Conference.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Lecturer, and an Assistant Lecturer, with special qualifications in Organic Chemistry, and a Lecturer in Physiology—The Secretary, The University, Edmund Street, Birmingham 3 (September 18).

Technical Officer, State Advances Corporation of New Zealand, Wellington (with a university degree, or its equivalent, in Applied Science, and a thorough knowledge of timber entomology, timber pathology and timber preservation)—The Official Secretary, High Commissioner for New Zealand, 415 Strand, London, W.C.2 (September 25).

Lecturer in Geology, within the Department of Agricultural Chemistry, and an Assistant Lecturer in Plant Diseases in the Department of Agricultural Botany—The Secretary and Registrar, University College of North Wales, Bangor (September 25).

Assistant in the Science Services Department, London Headquarters—The Director, Personnel Department, British Council, 3 Hanover Street, London, W.1 (September 25).

Lecturer (Grade II c or II b) in Petroleum Production Engineering—The Secretary, The University, Edmund Street, Birmingham 3 (September 30).

Biochemist with experience of research in cellular metabolism or enzymology for a research post in the Department of Lactational Physiology, to assist in the investigation of the intermediary metabolism of the mammary gland—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, Berks (September 30).

I.C.I. Research Fellowship in Pharmacology—The Secretary of University Court, The University, Glasgow (September 30).

Reader or Senior Lecturer in Applied Mathematics in the University of Adelaide—The Secretary, Universities Bureau of the British Empire, 32 Woburn Square, London, W.C.1 (September 30).

Lecturer in Psychology in the United College, St. Andrews—The Secretary, The University, St. Andrews (September 30).

Assistant Lecturer in Biochemistry—The Registrar, King's College, Strand, London, W.C.2 (September 30).

Senior Assistant in the Pathological Department—The Director, West Midlands Forensic Science Laboratory, Newton Street, Birmingham 4 (October 1).

Lecturer (Grade II c or II b) in Mining (Coal)—The Secretary, The University, Edmund Street, Birmingham 3 (October 1).

Research Assistantships (2) for work on (*a*) Physical and Chemical Aspects of Selective Flotation, and (*b*) Mining Research Problems—The Registrar, The University, Leeds 2 (October 4).

Senior Scientific Officers, and Senior Experimental Officers, for analytical work involving modern physico-chemical methods, in the Chemical Inspectorate (Atomic Energy), Ministry of Supply—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2281 (October 7).

Principal Scientific Officer or Senior Scientific Officer (with first- or second-class honours degree in metallurgy, and experience in the metallography of light alloys) in the Ministry of Supply Headquarters in London—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, W.1, quoting No. 2279 (October 8).

Lecturer in Medical Entomology—The Secretary, Department of Entomology and Parasitology, Liverpool School of Tropical Medicine, Pembroke Place, Liverpool 3 (October 30).

Botanists (2) to assist in the preparation of a Flora of East (Tropical) Africa, which is being undertaken by the Royal Botanic Gardens, Kew—The Under-Secretary of State, Colonial Office, Research Department, Sanctuary Buildings, Great Smith Street, London, S.W.1 (October 31).

Lecturer in Mathematics and Physics in New England University College (University of Sydney), Armidale, N.S.W.—The Secretary, Universities Bureau of the British Empire, 32 Woburn Square, London, W.C.1 (October 31).

Senior Lecturer (Grade I) in the Department of Geophysics—The Secretary, The University, Edmund Street, Birmingham 3 (November 13).

Production Pile Manager, and an Instrument Manager, in the Department of Atomic Energy, Windscale Works, Sellafield, Cumberland—The Staff Section, Ministry of Supply, Department of Atomic Energy, Risley, Warrington, Lancs.

Civilian Lecturer in the Department of Applied Mechanics of the Royal Naval College, Greenwich—The Secretary, The Admiralty (C.E. Branch I), London, S.W.1.

Demonstrator in Physiology—The Secretary, Charing Cross Hospital Medical School, 62 Chandos Place, London, W.C.2.

Laboratory Technician (experience in electronics essential)—The Director, Neurological Research Unit, National Hospital, Queen Square, London, W.C.1.

Technician (Grade B)—The Area Pathologist, Musgrove Park Hospital, Taunton.

Entomologists and Plant Pathologists in the Scientific Department of the East African Groundnut Scheme—The Personnel Manager (Scientific), Overseas Food Corporation, Unilever House, London, E.C.4.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Quarterly Journal of Mechanics and Applied Mathematics. Vol. 1, Part I, March 1948. Pp. iv + 124. (Oxford: Clarendon Press; London: Oxford University Press, 1948.) 12*s.* 6*d.* net; annual subscription, 40*s.* [156

British Electrical and Allied Industries Research Association. Technical Report W/T 15: Electrical Pre-Warming of Tomato House Soil. By C. A. Cameron Brown and E. W. Golding. Pp. 26. (London: British Electrical and Allied Industries Research Association, 1948.) 18*s.* [166

British Agricultural Bulletin. (Published quarterly for Overseas circulation only.) Vol. 1, No. 1, Spring 1948. Pp. 40. (London: British Council, 1948.) 5*s.*; 15*s.* for 4 Nos. [216

Interdepartmental Committee on Social and Economic Research. Guides to Official Sources, No. 1: Labour Statistics. Material collected by the Ministry of Labour and National Service. Pp. iv + 32. (London: H.M. Stationery Office, 1948.) 9*d.* net. [216

Air Ministry. Pilot Error: some Laboratory Experiments. By Dr. D. Russell Davis. (A.P. 3139.A.) Pp. iv + 39. (London: H.M. Stationery Office, 1948.) 9*d.* net. [216

Department of Scientific and Industrial Research. Report of the Chemistry Research Board for the Period 1938–1946, with Report of the Director of the Chemical Research Laboratory for the Year 1946. Pp. iv + 68. (London: H.M. Stationery Office, 1948.) 1*s.* 3*d.* net. [236

Modern Influences on the University Aspect of Professional Training in Surveying. By Prof. C. A. Hart. Pp. ii + 24. (London: H. K. Lewis and Co., Ltd., 1948.) 2*s.* 6*d.* net. [236

Symposium on Searchlights. Containing a Series of Five Papers presented at a meeting of the Illuminating Engineering Society held in London on April 15, 1947, the Discussion on those Papers and a further Written Contribution. Pp. 164. (London: Illuminating Engineering Society, 1948.) 17*s.* 6*d.* [246

Where to Buy Everything Chemical. Pp. 220. (London: Where to Buy, Ltd., 1948.) [286

Birds Month by Month and Country Magazine. Vol. 1, No. 1, June–July. Pp. 40. (London: Allman and Son (Publishers), Ltd., 1948.) 2*s.* 6*d.*; annual subscription, 16*s.* [286

Other Countries

Flora of South Australia. (Handbook of the Flora and Fauna of South Australia, issued by the South Australian Branch of the British Science Guild, now incorporated with the British Association for the Advancement of Science.) Part 2: Casuarinaceae—Euphorbiaceae. By J. M. Black. Second edition. Pp. 253–521. (Adelaide: Government Printer, 1948.) 8*s.* 6*d.* [226

German Hydrographic Journal. (Issued with the authority of the Allied Control Council of Germany.) Vol. 1, No. 1, January 1948. Pp. 44. (Hamburg: German Hydrographic Institute, 1948.) 3.50 R. marks. [226

American Mosquito Control Association. Bulletin No. 1: The Use of Aircraft in the Control of Mosquitoes. Pp. 74. (New Brunswick, N.J.: American Mosquito Control Association, 1948.) 1.25 dollars; to non-Members, 1.50 dollars. [236

Carnegie Institution of Washington. Publication 175: Magnetic Results from Huancayo Observatory, Peru, 1922–1935. Pp. vi + 609. 3.25 dollars. Magnetic Results from Huancayo Observatory, Peru, 1936–1944. Pp. v + 385. 2 dollars. (Researches of the Department of Terrestrial Magnetism, Vols. 10A and 10B.) (Washington, D.C.: Carnegie Institution, 1948.) [286

South African Journal of Science. Vol. 44: Being the Report of the Forty-fifth Annual Meeting of the South African Association for the Advancement of Science, Oudtshoorn, 30th June to 4th July 1947. Pp. v + 157. (Johannesburg: South African Association for the Advancement of Science, 1948.) 30*s.* net. [286

Papers of the Michigan Academy of Science, Arts and Letters. Vol. 31 (1945). Pp. x + 325. (Ann Arbor, Mich.: University of Michigan Press; London: Oxford University Press, 1947.) 21*s.* net. [286

Patents and Designs: Questions and Answers of Interest to Inventors and Industrialists. Pp. vii + 46. (Calcutta: Patent Office Society, 1948.) 2.8 rupees. [286

Atvinnudeild Háskólans (University Institute of Applied Sciences): Department of Agriculture. Reports, Series B, No. 2: Studies on the Origin of the Icelandic Flora, 1, Cyto-Ecological Investigations on Cakile. By Askell Löve and Doris Löve. Pp. 29. Reports, Series B, No. 3: Chromosome Numbers of Northern Plant Species. By Askell Löve and Doris Löve. Pp. 131. (Reykjavík: University Institute of Applied Sciences, 1947–1948.) [286

United States Department of Commerce: National Bureau of Standards. Atomic Energy Levels as derived from the Analyses of Optical Spectra. Vol. 1, Section 1: The Spectra of Hydrogen, Deuterium, Helium, Lithium, Beryllium, Boron, Carbon, Nitrogen, Oxygen and Fluorine. By Charlotte E. Moore. (Circular of the National Bureau of Standards, 467.) Pp. iii + 75. (Washington, D.C.: Government Printing Office, 1948.) 50 cents. [286

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TELEVISION DEVELOPMENT IN BRITAIN

AN important statement was issued on August 24 outlining the Government's policy on the development of television in Great Britain. It will be recalled that the Television Committee, under the chairmanship of Lord Hankey, issued its report early in 1945 with a number of specific recommendations on the manner in which, after the War, a public television service should be resumed and developed in Britain (see *Nature*, 155, 615 ; 1945). Acting with commendable speed and efficiency, the B.B.C. implemented the first of the recommendations by reopening the London Television Service from the Alexandra Palace Station in June 1946. Next, with the view of extending the existing service to other parts of the country, work was begun on a similar station near Birmingham.

Following a further recommendation of the Hankey Committee, the present Television Advisory Committee under the chairmanship of Lord Trefgarne was appointed, and has recently been examining the technical characteristics of the B.B.C. television system in the light of the latest developments which have taken place both in Great Britain and elsewhere. It is considered that the improvements in the quality of the picture presented by any of the alternative systems are slight from the point of view of the ordinary viewer, and are not sufficient to justify a change of system which would make all the present British receiving sets obsolete. Moreover, any change, such as the addition of another hundred or two hundred lines to the existing 405-line standard of definition, would prejudice more substantial improvements, including possibly colour, at a later date. Such developments need further prolonged research before they can be realized in practice, and so far as can be foreseen, this will take several years.

On the advice of Lord Trefgarne's committee, based upon the above considerations, the Postmaster-General has now announced that the London television station will continue to operate for a number of years on the 405-line definition system, and that the same system is being adopted for the Midlands station, and is proposed for other British stations. This timely re-affirmation of another of the recommendations of the Hankey Report puts an end to the uncertainty which has been created from time to time by the claims and propaganda for other systems. It also clears the way for the radio industry to prosecute its plans for developing television markets both at home and abroad. Now that the public has been given a reassurance that the existing system will be maintained, the industry is planning to produce half a million sets during the next three years. Also, every effort will be made to demonstrate the advantages of the British system which, if it were adopted as the standard in Europe, could provide a highly developed source of programmes and benefit from Great Britain's unique experience of television.

Work on the Midlands station at Sutton Coldfield is being pressed ahead, and it is hoped to open it in the autumn of 1949. The station, although working on the same basic 405-line system as the London station at Alexandra Palace, will have increased powers of the vision and sound transmitters of twice and four times respectively. The carrier frequencies used will be in the neighbourhood of 60 Mc./s., and the station, with its aerial system on a mast 750 ft. high, will have a reception range of approximately fifty miles. The Post Office is providing alternative radio and cable links to convey programmes from London to Sutton Coldfield. The B.B.C. is working out proposals for further television stations on the 405-line system, with the next station in the north of England. The completion of this development should make television available to the greater part of the population of Britain, and set a standard of service which other countries may wish to follow.

DEMOGRAPHY BETWEEN THE TWO WORLD WARS

Europe's Population in the Inter-war Years
By Dudley Kirk. (League of Nations: Economic, Financial and Transit Department, Publication 1946. II. A.8.) Pp. xii + 312. (Geneva: League of Nations; London: George Allen and Unwin, Ltd., 1946.) Paper, 15*s.*; cloth, 17*s.* 6*d.*

THE Office of Population Research, at Princeton, has abundantly justified its creation by issuing book after book of invaluable data often otherwise difficult to obtain. The book now reviewed is of primarily historical interest, as 1939 is almost lost in antique mist so far as demographic data and political units are concerned. Yet the data for those days must to a large extent remain our guide for the future in spite of the millions of displaced persons and the holocausts of victims of war and dictatorships.

The book is a modification of an earlier plan for a demographic atlas and it is well illustrated with maps and cartograms; but the author wisely emphasizes that a thousand persons in, say, northern Russia may be far more significant than a thousand people in some large urban centre; and on the other hand, he does not forget that, were spatial relations the only or even the main factor, London and the Low Countries would be the distribution centre for Europe. The student of population is always in trouble about the variable connotation of *rural* and *urban*, and this is one of many reasons why we should be grateful to Prof. Kirk for this book with explanatory discussion rather than only an atlas. A small community, of dormitory type, may be called rural simply because it is two or more miles from a town, and on the other hand, a large agricultural community, some attaining 50,000 people, may be called a town.

Estimates for Roman imperial territory run between twenty-three and thirty millions, so the population of all Europe at that time may have been some millions above this. Setbacks in the Dark Ages, through the black death and during the wars of religion, held back increase, so that estimates for 1600 are about one hundred millions, and people increased only slowly until 1750 when roads, communications, faster ships, banks, manufactures and so on started the great modern spurt, to 187 millions in 1800, 266 millions in 1850, 401 millions in 1900 and 540 millions about 1940. The fastest growth, be it noted, came between 1850 and 1900 when war devastation was relatively slight.

North-western and Central Europe had become before 1930 an area of incipient population decline, whereas in the U.S.S.R. increase is still very rapid; in fact, some fear a tendency to multiplication for some time so rapidly that standards of living may tend to sink to those which are such an unhappy feature of the monsoon lands of Asia. Another aspect of the situation is shown in the estimate (p. 64) that by 1970 there will be about 6·6 millions less men of military age in North-western and Central Europe but 13·2 millions more in the U.S.S.R. Military losses, excess civilian deaths and birth deficits together make war losses about 22 millions. Military losses in the Second World War were heavy on the eastern front but less elsewhere. The losses through systematized murder were very great, especially in Poland and Yugoslavia and Greece. It is estimated that the War's reduction of numbers in the U.S.S.R. was such that the population in 1946 was only equal to that in 1940 before the slaughter began. That equality was more or less attained gives an indication of the height of the birth-rate even during the War. The rise in birth-rates in Western Europe since 1945 may be a consequence of changes in social attitudes and in income schemes, but it may be in a considerable degree a result of the return of the men from the War. The dramatic falls in emigration to the United States after 1924 and to Canada and Latin America after 1930 are notable as a pointer to the reduced opportunities of open spaces. The emigrant would now tend to join an American proletariat, and in many cases he rather joins the proletariat in his own country and swells the prevalent discontent; movements from southern Italy to Milan and Turin are an important factor in Italian affairs. But, on the whole, birth-rates in cities are lower than in the countryside; and territory under Soviet influence generally proscribes emigration as a political crime.

Migration within Europe in the nineteenth century led to a large increase of population in the Ukraine; but in the twentieth century the most notable fact was the movement of Poles, Italians and some Spaniards to France, usually to try to cultivate the poorer soils or to do menial work, sometimes thereby making more 'superior' jobs for Frenchmen. In parts of south-east and north-east France aliens and naturalized persons were more than 10 per cent of the population about 1930; but the economic blizzard sent some Poles back to their native land. The immigrants to France naturally included a large proportion of men between twenty and forty-five. Parts of the south-east Plateau Central have lost population heavily. A renewal of migration within Europe on a large scale might become revolutionary in its effects; it proceeds, however, quietly and very effectively, generation after generation between Scotland and England in both directions.

Expectation of life has been lowest in Rumania and Yugoslavia, with Greece, Bulgaria and the U.S.S.R. a little better. It is highest in the Netherlands, Sweden, Denmark, Norway and Switzerland. Rumania in 1936–39 still lost more than 15 per cent of its babies in their first year of life.

The study of agricultural population could have been made more profitable by using more fully data collected by Dr. C. J. Robertson for a conference on rural life in 1939 and other analyses which show the crowding, under-employment and poverty of rural populations on several parts of the Loess zone of mid-Europe, a zone occupied from the early third millennium B.C. by peasants and clinging to traditional ways which the original fertility of the soil seemed to permit. In some parts of the Loess zone the yields of crops are very low, the holdings are miserably small, alternatives to farm work are far to seek, birth-rates remain high as usual among populations near the margin of subsistence. These parts would be better if 30–50 per cent of the population could be moved away. Even modernization of methods of cultivation would give only very partial relief.

But we must not ask for too much. Prof. Kirk has given us a mass of valuable data with a notable absence of tendentious arguments. The book should be in all serious libraries. H. J. FLEURE

ANCIENT EGYPTIAN MATERIALS AND INDUSTRIES

Ancient Egyptian Materials and Industries

By A. Lucas. Third edition, revised. Pp. xi+570. (London: Edward Arnold and Co., 1948.) 25*s.* net.

THIS book deals with a branch of prehistoric archæology in the Nile valley which the late Mr. Lucas made especially his own. So often prehistorians are mainly concerned with early sequence dating and a classification of the ancient objects found. But Mr. Lucas was interested in the details of the manufacture of everyday objects and of how and whence the necessary materials were obtained.

Although primarily dealing with the Nile valley and Egyptology, much of what he wrote can, with modification, be applied to other regions—at least from Neolithic times onwards. A glance at some of the chapter headings shows the kind of problems Mr. Lucas set himself to solve. For example, he asks what adhesives were used ? These were required for many purposes such as sticking sickle-blades into their hafts and preparing surfaces for tomb-paintings. In the latter case it had been thought that white of egg (from the eggs of wild-fowl, as barndoor hens were at that time unknown in the area) was used as a ground, but now on further investigation this does not seem so likely. But beeswax, glue, gypsum, resin, solder, etc., have all been identified. The need for beeswax led to the extensive cultivation of bees: some resins occurred locally, but the aromatic varieties used in perfumes, etc., had to be imported from southern Arabia. All primitive peoples manufacture some sort of alcoholic drink. What materials did the ancient Egyptians use for the purpose from predynastic times onwards ? It seems evident that both beer and wine were known, though it was impossible to produce any kind of spirit, as the process of distillation was unknown until much later. It appears to have been a new discovery in the time of Aristotle. What kinds of building stone were used, and how was granite cut at a time when steel was unknown ? What mortar was used ? How were finely made statuettes carved from very hard stones, and how were holes for suspension bored in such things as beads, amulets and the like ? "Cosmetics are as old as vanity." Yes, indeed, and perhaps we may be thankful that eyelids are no longer painted green, though blood-red nails are still with us. The green mineral malachite (a hydrated copper oxide) was used, being ground to powder on hard stones and made into a paste. Woodash fires (the ash containing alkali) over quartz pebbles, which had been so utilized as mortars, may have led to the discovery of the well-known blue glaze. Lead glaze came later. What metals were known at the various periods, and where were they mined ? How was mummification accomplished ? What was the process employed to obtain flat sheets of writing material from the pith of the plant papyrus ? These and many other fascinating questions are posed and answered by Mr. Lucas.

Finally, there is given a brief historical survey, and the above information is fitted, as it were, into the historical sequence.

It is very pleasant to find a chemist, trained in accurate determination, dealing with such prehistoric problems. There are some prehistorians who have reached back to their subject from their later historical studies; they bring with them the historian's outlook. Others again reach up from geological investigation and bring to bear on the problems the geologist's point of view. Here we have the chemist's outlook, and it is both novel and stimulating. Of course, Mr. Lucas was not the first of his kind to envisage such investigations; but he of all others had particularly made it his own. He opened up the new field in his earlier editions, and this revised and more definitive volume will be welcomed by all who are directly or indirectly interested in the way men lived in the Nile valley in the remote past. M. C. BURKITT

RECENT RESEARCHES IN PHYSIOLOGY

Annual Review of Physiology

Victor E. Hall, Editor; Jefferson M. Crismon, Associate Editor; and Arthur C. Giese, Associate Editor. Vol. 10. Pp. xi+552. (Stanford, Calif.: Annual Reviews, Inc., 1948.) 6 dollars.

IT is rather a sobering thought that within three years of the end of the War a book of more than five hundred pages is required to review the written contributions to one small corner of biological science. With such a literary output some kind of annual survey is clearly necessary, if only as a time-saving measure, to guide the worker or student to those articles relevant to his interests. Reviews, however, are something more than intelligently arranged catalogues, for they can present a periodical appreciation of the state of knowledge in the various fields and in this way help a worker to follow general trends in branches of the science other than his own. A third value to be attached to such surveys is that, by their general dissemination, they can exert a unifying influence which may be considered a direct contribution to a truly international spirit.

Viewed from these three points of view, the tenth volume of "Annual Review of Physiology" has great merit. A wide range of subjects is covered in its twenty-three sections, the only notable deficiency being "Excretion", and this omission is due to circumstances beyond editorial control.

As a guide to publications, each section provides a generous bibliography and there are large author and subject indexes. Certain sections have their bibliographies arranged in alphabetical order; this has a distinct advantage over a chronological arrangement where the reference hunter is concerned.

The most valuable sections are those in which the authors have made some assessment of the significance of the results recorded, or have attempted to harmonize evidence from various sources or to formulate plans for the resolution of conflicts or problems developed in the articles under review. Of course, this can only be attempted in a limited number of cases, but such constructive presentation is very helpful and fully justifies the careful selection of authors by the editorial board. Noteworthy examples of this type are found in Eccles' discussion on conduction in nerve, Osgood's account of hæmoglobin formation and erythropoiesis, Wilhelmi's picture of the significance of hepatic anoxia in shock, Brobeck's attempt to harmonize the 'central' and 'gastric' components of hunger and Anderson's account of thyroid physiology.

The third potential of this publication, its international influence, is recognized by the editorial board in the preface. The board regrets the persistence of difficulties in obtaining contributions from a truly universal field, but affirms its intention to persist in its attempts to overcome these barriers. In this it must receive every encouragement from those who believe in scientific freedom.

A COMPARATIVE HISTOLOGY OF VERTEBRATES

Microscopic Anatomy of Vertebrates

By Prof. James I. Kendall. Third edition, thoroughly revised. Pp. 354. (London: Henry Kimpton, 1947.) 30*s*. net.

It is a defect of the great majority of text-books of histology that, being intended chiefly for medical students, they wholly neglect all vertebrate classes except the mammals. As a result, students of zoology either learn no histology, or, being led into the subject by men whose interest is limited to one class, and even to one species, acquire a slight superficial knowledge with the same limitation. The book under review attempts to tackle the subject in a less limited manner. Inevitably, because of the vast preponderance of work done on mammals, it is heavily influenced by our knowledge of the microscopic anatomy of that class; but it is rich in descriptions of histological structures in other classes. Thus, the chapter on the integument deals with the skins of the dog-fish, of teleostean fishes, of the frog, reptiles, birds and mammals; that on excretory organs discusses separately the pronephric, mesonephric and metanephric kidneys, as illustrated in such animals as the hag-fish, the frog and the mammal.

Of course, no book of this kind, held within these limits of size, could satisfy every reviewer, and the present reviewer would have preferred greater emphasis on considerations of function and especially, where possible, on the functional differences correlated with differences of structure. On points of detail, one is made a little uneasy by finding the terms 'pre-cartilage', 'chondroid tissue' and 'pseudo-cartilage', used as synonyms. In the section on bone there does not seem to be any recognition of the existence of a microscopically homogeneous substance between the fibres, or of a distinction between lamellar and non-lamellar types of bone. The description of the dog-fish skin and placoid scale could well be revised, and the figure replaced; in the ganoid scale it is incorrect to describe the ganoin layer as "fibrous and uncalcified". In the paragraph on myogenic and neurogenic theories of heart-beat, statements are made which will lead students to believe that the elasmobranch heart is two-chambered and that of amphibians three-chambered.

The book is well illustrated with photomicrographs and diagrams, a number being new since the second edition. Some of the diagrams are rather crude, and one would have liked to see an illustration which would have made easier the identification of leucocytes in some laboratory animals below the mammalian level, especially of the Amphibia.

However, the reviewer, having done his duty by carping a little, would like to end: this is a good book, and it should be in every zoological library.

P. D. F. Murray

CYANOGEN COMPOUNDS

Cyanogen Compounds:

Their Chemistry, Detection and Estimation. By Herbert E. Williams. Second edition. Pp. xvi+ 443. (London: Edward Arnold and Co., 1948.) 40*s*. net.

The chemistry of the cyanogen compounds is one of the more difficult branches of the subject, and is one on which it is not easy to find collected information. The first edition of this book, published in 1915, served a very useful purpose in bringing together a large amount of information in a systematic form, and the new edition is necessary in view of the work which has appeared since that time. The treatment is practical, scarcely any space being given to theory, and in some cases this is a real defect of the book. The only formula for Prussian Blue is an old one which is incorrect, no notice being taken of recent work in this field which has cleared up much obscurity. Many of the formulæ given in all parts of the book are semi-empirical, and some account should have been taken of modern co-ordination formulæ for the compounds.

The treatment covers all that could be expected from the title, and a praiseworthy feature is the inclusion of many compounds which have not been investigated for a long time, some of which would, no doubt, repay new work and show interesting and useful properties. The chapters include the subjects of cyanogen and its derivatives, cyanamide, urea and related compounds, cyanates, cyanides, iron-cyanogen compounds, nitroferricyanides, thiocyanates, and five chapters on analysis, which are particularly noteworthy. References to literature are mostly given, and some patents are listed.

The book, taken as a whole, is good, and is one which should be found useful in the laboratory. The absence of an adequate theoretical background makes it essentially a work of reference. The reviewer noticed an unusually large number of errors in names, many of which appear also in the index: these include "Maequer" for Macquer, "Vanquelin" for Vauquelin, "Hautefeville" for Hautefeuille, "Blitz" for Biltz, etc. This creates a certain lack of confidence in the accuracy of the text. Some ordinary words also appear in unfamiliar forms:

"defraction" appears for diffraction, "tantallium" for tantalum, "turpin" for terpene, etc. Although the author claims that the full references will enable his often sketchy accounts to be extended, references are sometimes missing, as, for example, in the inadequate paragraph on cyanogen fluoride.

J. R. Partington

COLONIAL NATIONAL INCOMES

The Measurement of Colonial National Incomes

By Phyllis Deane. (National Institute of Economic and Social Research, Occasional Papers, No. 12.) Pp. xvi+173. (Cambridge: At the University Press, 1948.) 12*s.* 6*d.* net.

ONE of the most serious gaps in our knowledge of the Colonies has been the lack of adequate statistical analysis of their economic structures. True, there is much scattered statistical material, but it is not always easily accessible and little work has been done to bring it all together to form comprehensive surveys of the Colonial economies.

This book, of its kind a pioneer study, does much to fill this gap, in respect at any rate of three Colonial territories, and ably shows the possibilities as well as the difficulties of extending this work to other Colonies. The main objects of Miss Deane's study were, first, to discover by experiment the possibilities and limitations of applying to the Colonies the techniques evolved for the measurement of the national income of the United Kingdom; and secondly, to throw light on the economic structure and problems of the areas studied. For these purposes three Colonies were examined, Northern Rhodesia, Nyasaland and Jamaica, and their national incomes for the year 1938 calculated. As this inquiry had its beginnings in the early part of the War, 1938 was thought to be the most suitable year for which to make the calculation as there appeared to be relatively more material for that year than for other recent years. Nevertheless, it is impressed upon us throughout the study that the main limitation of all the calculations is lack of data. Moreover, the inquiry was carried out under all the difficulties of war-time London, without first-hand knowledge, by way of field-work, of the territories to which they relate, and therefore the results must be regarded as highly tentative and insufficient to "support firm conclusions on economic conditions in detail". It is the purpose of the research project, however, that the inquiry should be carried into the field.

Mention merely of two problems will serve to illustrate the difficulties that Miss Deane had to face. The first is that of measuring the national income of a territory where a large proportion of the inhabitants are wholly dependent, or nearly so, on subsistence farming; and secondly, the problems created by the existence of two races in one Colony, Africans and Europeans, the latter often with little degree of permanency, and where a significant proportion of the wealth created in the area in fact goes abroad in the form of profits, rents, interest and extra-colonial expenditures. That there are bound to be errors of calculation in the attempt to circumvent such problems with so little data is inevitable; the surprising fact is that the margins of error which Miss Deane has worked out for her calculations should be so small.

But even for those not versed in the finer points of statistical practice there is much that is revealing about the Colonies in the figures presented. In fact, at the end of her study. Miss Deane suggests some of the more obvious ways in which the figures may be applied to bring out certain conspicuous features of Colonial economies, for example, the proportion of income that flows abroad from such territories, the distribution of income between Europeans and Africans, the industrial structure of the economies and so forth. Above all, for the purposes of planning Colonial economic development such figures are absolutely essential. Planning, to be successful, must be done in the light of its effect on total national income, its distribution, and on the channels by which it is spent. For purposes of Colonial development, therefore, we are going to need many more Colonial national income calculations such as the painstaking work Miss Deane has given us—and the sooner the better.

D. Randal Wightman

BIRD PICTURES

Fifty Prints

By Emerson Tuttle. With an Introduction by Chauncey Brewster Tinker, a Critique by Lewis E. York, and a Complete Catalogue from 1921 to 1946. Pp. xv + 21 + 50 plates. (New Haven, Conn.: Yale University Press; London: Oxford University Press, 1948.) 82*s.* 6*d.* net.

Wings in the Wilderness

By Allan D. Cruickshank. Pp. xiv + 125 + 125 plates. (New York and London: Oxford University Press, 1947.) 35*s.* net.

THE beauty of the bird, its elegance, its grace and its wonder of colouring have ever attracted the artist; note, for example, the prominence of the bird in Chinese and Japanese art. We have here two books dealing with bird portraits, in which the artistic theme is the predominant one; but the approach is from different angles, one being that of the etching and the other that of the camera.

The first mentioned is a collection of fifty prints by the late Emerson Tuttle. There are landscapes among them, but the greater part consist of portraits of birds, including many pictures of owls and hawks. Feather texture and bird character are remarkably delineated in these dry-points, the owls being especially satisfying, in particular the portrait of a snowy owl. The feathers are so soft and fluffy you feel as if you must stroke them. One mammal breaks the sequence, an alert and vigorous red squirrel.

In "Wings in the Wilderness" we have reproductions of 125 photographs from the camera of Mr. Allan Cruickshank, in which birds and birds only are portrayed, and as in the case of Mr. Tuttle's pictures, chiefly the birds of North America. We are accustomed to think that British bird photographers do well with their cameras; but this volume shows the high standard achieved by the ornithological camera users of the United States. Young birds, old birds, birds feeding young, birds swimming and birds in flight are portrayed with great skill. Among so many masterpieces of the camera, it is difficult to select pictures for particular praise; but the osprey on the wing is remarkably good and the wild turkey, a fine old gobbler, of especial interest. This is a book to interest everyone who has ever taken a snapshot of a bird.

Frances Pitt

The Feeding of Farm Livestock

By J. C. B. Ellis. (Agricultural and Horticultural Series.) Second edition, revised. Pp. xiv+271+26 plates. (London: Crosby Lockwood and Son, Ltd., 1947.) 18*s.* net.

THE author's primary object has been to show how rations for any class of livestock may be constructed by the use of the Kellner starch equivalent system and protein equivalents as measures for energy and protein requirements, and this object he has achieved in a smooth and satisfying manner. Like other books on the scientific feeding of farm animals, this volume conforms to the usual pattern, a preliminary explanation of the theoretical bases of scientific rationing being followed by a general description of feeding stuffs in common use, while in the latter chapters the principles of the rationing and management of the various classes of farm livestock are clearly and simply expounded. Following the experimental results of American investigators, the author has based the maintenance requirements for energy on the three-fourths power of the live-weight of the animal instead of on the usual surface law, and has also applied the same principle to the protein requirement estimations.

Owing to compression of material, the reader may be led falsely to assume that digested fat material is transported in the portal blood stream (p. 14), that ptyalin is present in the saliva of all animals (p. 13), and that metabolizable energy is the same as gross digestible energy (p. 23). There are also a few typographical and cross-indexing errors (pp. 1, 12, 214, 215 and 219). Apart from these minor faults, the book is attractively produced, the print is very readable, and the twenty-five photographic illustrations help materially to sustain the reader's interest.

E. T. HALNAN

Tables of Supersonic Flow Around Yawing Cones

By the Staff of the Computing Section, Center of Analysis, under the direction of Zdeněk Kopal. (Massachusetts Institute of Technology, Department of Electrical Engineering, Center of Analysis, Technical Report No. 3.) Pp. xviii + 321. (Cambridge, Mass.: Massachusetts Institute of Technology, 1947.) n.p.

THESE tables are prefaced by an account of the theory, which is based on work by Stone, hitherto unpublished. It is assumed that the motion is steady and isentropic along each streamline behind the shock wave, but not irrotational. The steady angle of yaw is taken to be a small quantity of the first order, and the equations for the first order perturbations of the known flow for zero yaw are worked out. Ultimately the solution is made to depend on a non-homogeneous ordinary differential equation of the second order. It appears that the shock wave is a circular cone the angle of yaw of which differs from that of the body.

Numerical integrations of the fundamental differential equation are the basis of the tables. The ratio of the specific heats for air is taken as 1·405 and the semi-apex angle of the cone ranges from 5° to 15° in steps of 2½°, and upward to 50° in steps of 5°. For each apex angle results are tabulated for equally spaced values of the ratio of the axial component of velocity at the surface to the velocity of escape into a vacuum. Consequently the Mach numbers, which are stated, show irregular increments.

W. J. DUNCAN

The Experimental Situation in Psychical Research

By S. G. Soal. (Being the Ninth Frederic W. H. Myers Memorial Lecture, 1947.) Pp. iv + 64 + 4 plates. (London: Society for Psychical Research, 1948.) 2*s.*

IN the ninth Frederic W. H. Myers Memorial Lecture, Dr. S. G. Soal has given an admirably succinct summary of the present situation as regards experimental psychical research, and has added a few short criticisms on the various attempts now being made to bring the phenomena of telepathy and telæsthesia under a rigid system of control. He describes his own experiments with Mr. Shackleton and Mrs. Stewart, briefly considers the various group experiments associated with the late Mr. Whately Carington, and has a few words to say on the Duke University series and the picture tests favoured by Dr. Hettinger.

From the results of his own work, Dr. Soal thinks that it is largely a waste of time to conduct mass experiments with unknown percipients unless it be with the view of discovering sensitives of marked ability. He prefers to concentrate attention on persons of promise and, if possible, develop the faculties so that they may become amenable to experimental procedure and the results to statistical analysis. Unfortunately, good subjects and trained experimenters are rare, so that the prospect of rapid progress does not appear to be bright. The technique for a repeatable experiment already exists; but for this to be successful the co-operation of a reliable subject must be obtained, and thus the search for such subjects must be considered to be of major importance.

Nairobi, Master Plan for a Colonial Capital

A Report prepared for the Municipal Council of Nairobi. By Prof. L. W. Thornton White, L. Silberman and P. R. Anderson. Pp. vii + 92. (London: H.M. Stationery Office, 1948.) 21*s.* net.

NAIROBI started in 1896 as a transport depot on a site that was none too favourable except for the railway which reached it three years later from the coast. Since then it has grown rapidly but largely without a plan, and now, with more than 100,000 inhabitants, is one of the largest inland towns of tropical Africa. The population is mixed, with Bantu Negroes in the majority; next in number Indians, and fewest, but in a dominating capacity, Europeans. At an altitude of 3,600 feet it has a climate suitable for Europeans and its centrality marks it out as the eventual capital of all European-held East Africa. At its present rate of growth it should reach nearly 300,000, which the authors think will be a desirable size about 1975, that is to say, if the serious problem of an adequate water supply can be solved. The rapid rise called for the planning and regulating of the town growth, and the present volume is the outcome of a careful study of the site and the functions of the town both at present and in the years to come. It was prepared at the instigation of the Municipal Council of Nairobi by an architect, a civil engineer and a sociologist. The inclusion of the last in the team was a recognition that problems of race, caste and religion as well as purely material considerations had to be faced. The report not merely plans Nairobi for many years to come; it is also a discussion of the problems involved by Europe's introduction of the town and all it involves to the agricultural and pastoral peoples of tropical Africa.

OBSERVATIONS ON SLOW MESONS OF THE COSMIC RADIATION

By U. CAMERINI, H. MUIRHEAD
AND
DR. C. F. POWELL
H. H. Wills Physical Laboratory, University of Bristol
AND
D. M. RITSON
Clarendon Laboratory, Oxford

Introduction

RECENT observations[1] have indicated that the slow negative mesons observed to be created in nuclear interactions taking place in photographic emulsions exposed to the cosmic radiation can produce disintegrations of both light and heavy nuclei. Both the modes of creation and extinction, of at least the majority of these particles, are therefore consistent with the assumption that they have a strong interaction with nucleons. In this paper we describe experiments which indicate that the negative mesons of mass $\sim 200\, m_e$ in the penetrating component of the cosmic radiation, even when captured by heavy atoms, rarely, and possibly never, produce disintegrations of nuclei with the emission of heavy charged particles.

The results also show that in experiments made near the ground, there is present, in addition to the downward stream of mesons of mass $\sim 200\, m_e$, an upward stream of similar particles with an intensity approximately half that of the downward component. These mesons are accompanied by σ- and π-mesons, and a comparison of the relative numbers of the different types allows us to make an estimate of the mean life-time, τ_π, of the heavy particles. The value thus obtained is $6 \pm 3 \times 10^{-9}$ sec.

Experimental Method

The present experiments were initiated as part of a series designed to determine the life-time of the different types of mesons present in the cosmic radiation. The main principle of the investigation was to observe the reduction in the number of heavy positive and negative mesons ($\sim 313\, m_e$), brought to rest in our emulsions after being generated in matter disposed around the plates, as the distance between the plates and the surrounding matter was increased.

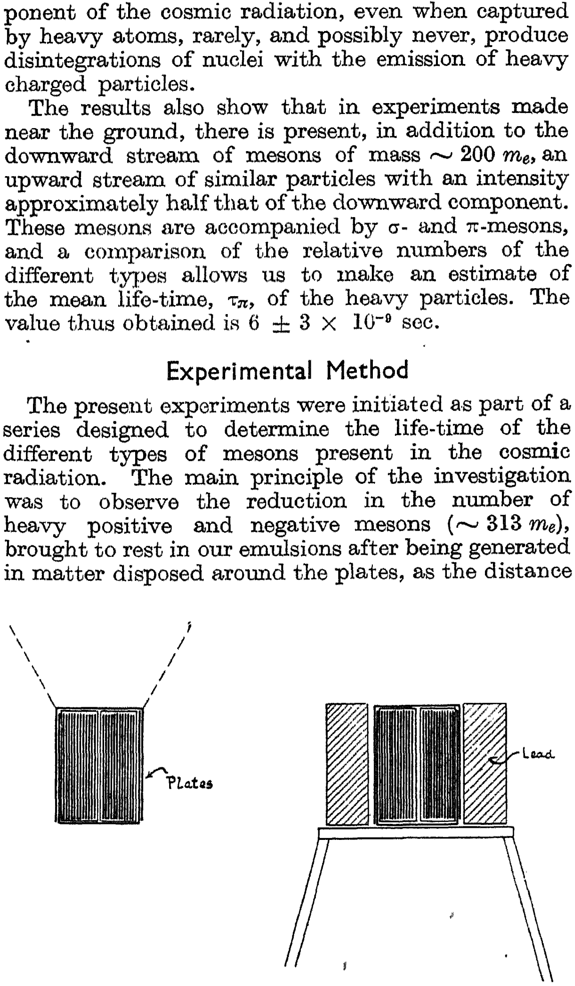

Fig. 1. Experimental arrangement

As a first step in this programme, preliminary experiments were made at the Jungfraujoch with the simple arrangement shown in Fig. 1. We anticipated that the observations would allow us to determine the quantity of neighbouring matter which it would be necessary to employ in order to obtain a sufficient increase in the number of tracks of heavy mesons. In each case, twenty-four plates, Ilford Type *C*2, boron-loaded, 100 μ thick, in their original packing, were enclosed in a box of tinned iron (0·5 mm. thick), and supported 2 metres from the floor, and about 60 cm. below a light roof, with the surfaces of the emulsion lying in a vertical plane. In one case the plates were supported from the roof by strings; in the other they were placed on a light iron tripod, and surrounded on the four sides by lead blocks 5 cm. thick, the top and bottom of the assembly being left free.

After an exposure of 35 days, the plates were marked so that their orientation during the exposure and their order in the assembly was known; and they were afterwards developed by the methods recently described[2]. The present results were obtained in the microscopic examination of 9·6 cm.^{3} of the emulsion of the plates thus obtained. In analysing the experimental results, we employ the classification for the different types of mesons given in an earlier paper[1]. The terms 'ρ-meson', 'σ-meson', etc., are employed for the different categories of mesons classified phenomenologically; and 'π-particle', 'μ-particle', when it is possible to distinguish particular types more precisely.

Angular Distribution of the ρ-Mesons

The directions of motion of the mesons, at their points of entry into the emulsion, were first determined. In every case, we chose to measure only the angle, relative to the vertical, of the projection of the track on the plane of the emulsion. The resulting angular distributions thus obtained, for ρ-mesons, are shown in Fig. 2*A*, the full lines corresponding to the measurements on the plates obtained without lead, curve *a*; and the dotted lines, to those obtained with lead, curve *b*.

It will be seen from Fig. 2*A* that, both in the experiments with and without lead, there is a pronounced downward flux of particles accompanied by an upward stream of about half the intensity; and that the numbers of particles in these directions are not appreciably influenced by the presence of the lead. The difference in the two distributions is given in Fig. 2*A*, curve *c*, and shows that a considerable number of ρ-mesons enter the plates in directions which indicate that they come from the lead.

We must anticipate that the Coulomb scattering in the plate assembly will cause the observed directions of motion to differ from those of the particles before they have been reduced to the relatively low speeds at which we can observe them. An analysis indicates, however, that these changes in direction are not serious, and that the original distribution must have been similar to that observed. Deviations become more frequent as the velocity of a particle is reduced, and we have therefore drawn the corresponding angular distributions for those particles of residual range greater than 300 μ. These are shown, in the form of a polar diagram, in Fig. 3, curves *a* and *b*, and display the same features as the results obtained by including the measurements made for

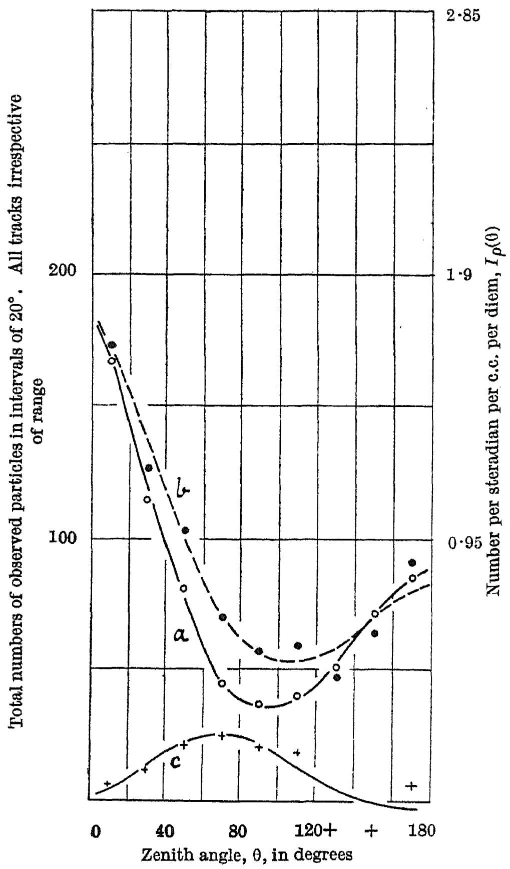

Fig. 2A. Experimental results, ρ-mesons
Curve (a), exposure without lead; (b) exposure with lead; (c) difference between (b) and (a)

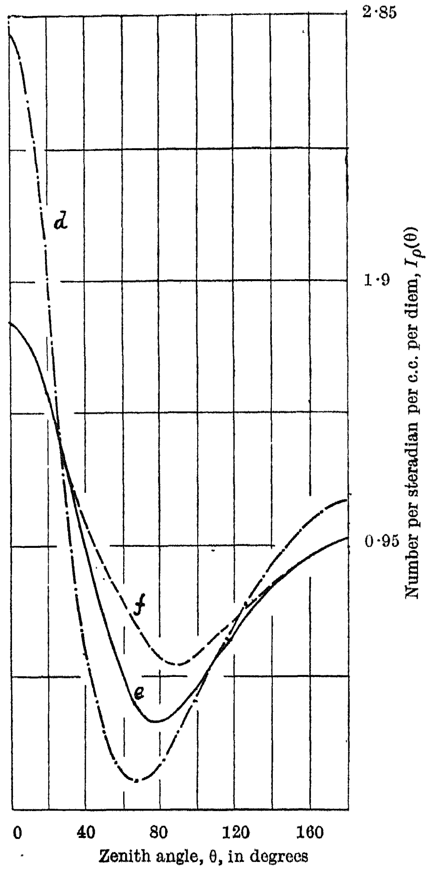

Fig. 2B. Calculated distributions to fit experimental data. Curve (d) calculated original angular distribution unmodified by scattering; (e) estimated distribution to be observed in experiment without lead; (f) similar distribution with lead. Curves (e) and (f) are calculated for tracks greater than 300 μ

all mesons, irrespective of their residual range in the emulsion, curves c and d. It is a satisfactory feature that the pronounced 'waist' in the distribution without lead is accentuated when the results for the short tracks are excluded.

We have estimated the original distribution of the directions of motion of the mesons which stop in the plates, employing the scattering formulæ developed by E. J. Williams, and the result is shown in Fig. 2B, curve d. Owing to scattering in the plates, such an original distribution should appear in the experiments without lead like that shown in curve e of the same figure; and, in the experiment with lead, as curve f.

The estimated original angular distribution of the downward flux of mesons appears to be in reasonable agreement with the measurements, made by Greisen[3] with a counter telescope, on the mixed stream of electrons and slow mesons which form the soft component of the cosmic radiation.

As a step towards calculating the absolute intensity of the mesons, we have plotted the distribution in range of the observed particles. In agreement with the previous results[4], the observations show that the observers record the mesons, of which the length of the projection of the track is greater than 200μ, with constant efficiency. Further, the consistency between the results of two observers, obtained in the examination of the same plate, shows that this efficiency is close to unity. The absolute intensity, $I_\rho(\theta)$, the number of ρ-mesons per c.c. per unit solid angle per

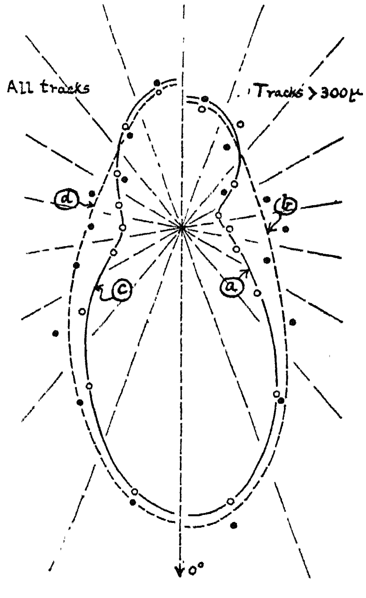

Fig. 3. Polar diagram showing angular distributions observed experimentally. (a) Tracks longer than 300 μ, without lead; (b) with lead; (c) all tracks, without lead; (d) with lead

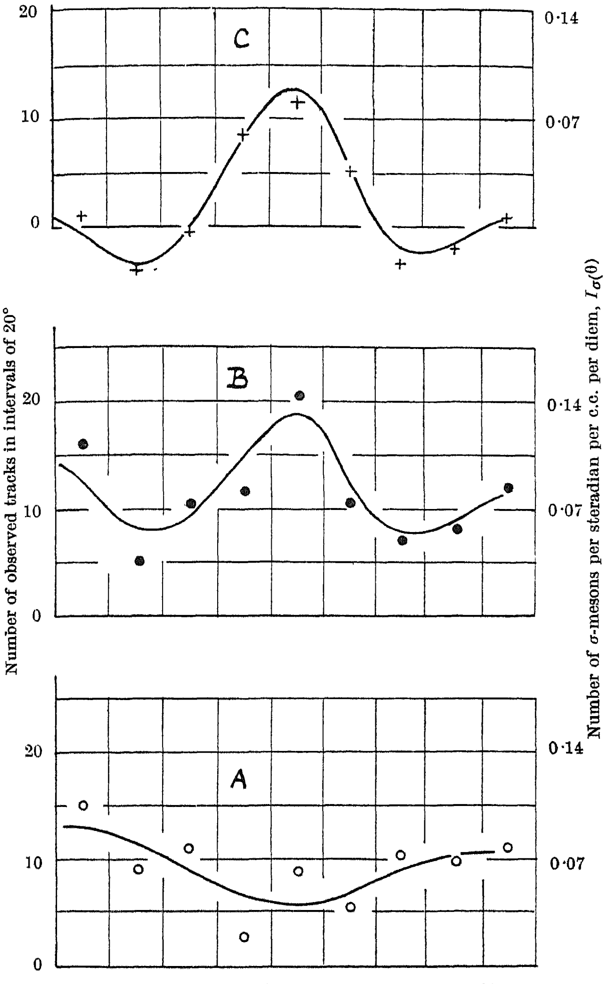

Fig. 4. Angular distribution of σ-mesons. (*A*) Without lead (*B*) with lead; and (*C*) difference (*B*)–(*A*)

diem, has been calculated, therefore, from the numbers of tracks of which the projections are greater than 200 μ, using a procedure similar to that described in a previous paper[4]. This has allowed us to insert a scale of absolute intensity in Figs. 2 and 4.

Angular Distribution of σ-Mesons

The number of tracks of σ-mesons in the volume of the emulsions examined hitherto is much smaller than that for the ρ-mesons, so that the statistical fluctuations are more serious. The results are shown in Fig. 4, *A* and *B*, for the exposures with and without lead. It will be seen that the addition of the lead results in a considerable increase in the number of σ-mesons and that these enter the emulsions in directions which indicate that they have originated in the lead. In Fig. 4*C*, we plot the difference in the two distributions. Although the standard deviations associated with each of the points in this figure are relatively large, so that the small departures of the points from the smooth curve drawn through them must be regarded as fortuitous, Fig. 4*C* gives good evidence for the existence of a pronounced lateral stream of σ-mesons, produced by the presence of the lead.

Interpretation of Observed Angular Distributions

The above observations can be interpreted in terms of the relations of the mesons of different types, outlined in the previous paper. We regard the downward stream of ρ-mesons as corresponding to the particles of the penetrating component of the cosmic rays, which originate by the decay in flight of π^+- and π^--particles formed in the atmosphere.

Strong support for the view that the particles in the main downward stream observed in the present experiments are identical with the mesons of the penetrating component is provided by a comparison of our results with the observations of Rossi, Sands and Sard[5]. These workers have investigated the rate of arrival of slow mesons with a life-time of 2·2 μsec., using a delayed coincidence method, at an altitude of 14,000 ft. We have recalculated their results on the assumption that the energy of the electrons formed by the decay of the mesons is 25 MeV., as suggested by the recent experiments of Anderson and his colleagues[6]. The values so obtained can be compared with the rate of arrival of mesons in our emulsions from all directions in the upper hemisphere. The two values are thus found to agree to within 30 per cent (see Table 2).

Table 1

Ratio of the integrals, $N = \int I(\theta).d\theta$, for different intervals of the angle θ. $I(\theta)$ = the intensity per steradian per cm.³ per diem, at the Jungfraujoch, 11,000 ft.

Interval in θ°	With lead		Without lead	
	$N_\sigma/N_\rho \times 10^{-2}$	$N_\pi/N_\rho \times 10^{-2}$	$N_\sigma/N_\rho \times 10^{-2}$	$N_\pi/N_\rho \times 10^{-2}$
0– 40	5·0 ± 1·3	3·5 ± 2·1	5·8 ± 1·5	3·5 ± 2·1
60–120	21·0 ± 3·6	18·1 ± 6·8	9·2 ± 2·5	12·0 ± 6·0
140–180	7·2 ± 2·1	16·7 ± 6·7	11·5 ± 2·6	6·6 ± 4·1

Table 2

Values of the total integrated intensity, $J^\pi = \int_0^\pi I(\theta).\sin\theta.d\theta$ in mesons per cm.³ of the emulsion per diem, for different classes of mesons, at the Jungfraujoch, 11,000 ft.

	J_ρ	J_σ	J_π
With lead	8·42 ± 0·48	1·09 ± 0·14	1·04 ± 0·35
Without lead ..	7·59 ± 0·46	0·74 ± 0·11	0·68 ± 0·23
Mean values ..	8·0 ± 0·3	0·9 ± 0·1	0·9 ± 0·2

For ρ-mesons, in the exposures made without lead, the total intensity in the upper hemisphere, $J^{\pi/2}$, is 4·1 mesons per cm.³ per diem. The calculated value, based on the experiments of Rossi, is found to be ~3 mesons per cm.³ per diem, assuming the decay electron to have an energy of 25 MeV.

We attribute the difference in the two distributions of the ρ-mesons, observed in the exposures with and without lead, to the particles in the main downward stream which have been scattered into the plates in traversing the surrounding lead. A comparison of the calculated curves Fig. 2*B*, curves *e* and *f*, with the corresponding experimental results represented in the accompanying diagram, 2*A*, shows that we can thus account for at least a large part of the increased number of ρ-mesons. We cannot, however, exclude the possibility that some of them are due to particles which have been created in the lead.

The form of the distribution in angle of the σ-mesons, in the exposure made without lead, is similar to that of the corresponding curve for ρ-mesons. We attribute the lateral stream of σ-mesons, produced by the addition of matter around the plates, to negative mesons produced in the lead which have not had time to decay in flight. The distribution in angle of these mesons is consistent with this assumption. The presence of the lead also gives rise to an increase in the number of π-mesons, but in this case, because of the low probability of observing these particles[4], the numbers are too small to allow any conclusions to be drawn regarding their distribution in angle.

Nature of the ρ-Mesons in the Upward Stream

If we apply a similar analysis to the meson stream arising from the matter beneath the plate assembly, we find that the ratio of the numbers of ρ- to σ-mesons is about half as great as that observed in the main downward stream (see Table 1). It seems reasonable to suppose that the ρ-mesons are in this case, also, composed mainly of μ^+- and μ^--particles, formed by decay in flight; and that in spite of the relatively close proximity of the matter in which the parent π-particles are produced, only a small fraction of them reaches the emulsion before they have decayed.

Comparison of the Number of ρ- and σ-Mesons in the Downward Stream

It is of great interest to compare the downward intensity, $I_\rho\,(\theta)$, of the ρ-mesons, measured in mesons per steradian per cm.^{3} per diem, with the corresponding quantity for σ-mesons, $I_\sigma\,(\theta)$. The estimated number of ρ-mesons entering our plates, in the angular range 0–40° with the vertical, $N_\rho{}^{40°} = \int_0^{40°} I(\theta)\,.\,d\theta$, is $0{\cdot}86 \pm 0{\cdot}07$ per cm.^{3} per diem. The corresponding value for the σ-mesons, $N_\sigma{}^{40°}$, is $0{\cdot}05 \pm 0{\cdot}01$.

Reference was made in the previous paper to recent observations on the sign of the charge of the ρ-mesons, using the method of magnetic deflexion, by which it was shown that approximately half these particles are negatively charged. This result is in accord with magnetic deflexion experiments made with expansion chambers on cosmic ray mesons[7]. In order to allow for a small positive excess, and for the presence among the ρ-mesons of some π-mesons of which we fail to distinguish the tracks of the associated μ-mesons, we shall assume that 40 per cent of the ρ-mesons are negatively charged. It follows that the number of negative ρ-mesons in the downward stream (0–40°) is $0{\cdot}34 \pm 0{\cdot}03$ per cm.^{3} per diem.

Of all the negative mesons in the downward stream, a certain fraction, f, will be stopped in silver bromide grains and will be captured by atoms of high atomic number; and the remainder, $1-f$, will be brought to rest in gelatine. Through the kindness of Dr. Gardner and Mr. Lattes, two of us (U. C. and H. M.) have recently obtained plates exposed to the negative mesons generated artificially at Berkeley. The emulsions of these plates were made up of alternate layers of normal emulsion and of pure gelatine. It was thus possible to study the difference in behaviour of the mesons stopped in gelatine, and of those stopped in the mixture of gelatine and silver bromide composing the ordinary emulsion. Among other features, the observations made it possible to show that the fraction, f, of negative mesons stopping in a normal emulsion which are captured by heavy atoms is greater than $0{\cdot}3$. Theoretical estimates of the stopping power of the different constituents of the emulsion give values lying between $0{\cdot}4$ and $0{\cdot}6$, and we shall assume that $f = 0{\cdot}5$.

It is known, from the delayed coincidence experiments, that most of the negative mesons of the cosmic rays, of which the life-time is $2{\cdot}2$ μsec., undergo normal decay with the emission of an electron, when brought to rest in light elements. We shall therefore not expect to observe disintegrations produced by those of the μ-mesons, whether positively or negatively charged, which stop in the gelatine of the emulsion; and we confine our attention to those negative mesons which stop in silver bromide.

Let us assume tentatively that all the σ-mesons in the downward stream are μ^--particles. We must then conclude that the number of μ^--particles which produce observable disintegrations, in comparison with the total number of ρ-mesons, is less than 6 per cent (Table 1). Further, if 40 per cent of the ρ-mesons are μ^--particles, it follows that only 15 per cent of the latter produce observed disintegrations. Taking $f = 0{\cdot}5$, we conclude that only 30 per cent of the μ^--particles which stop in silver bromide produce observable disintegrations.

The above values must represent upper limits, for a certain fraction, φ, of the σ-mesons must be heavy particles with a strong interaction with nucleons. There is good evidence that φ is nearly equal to unity. Thus we can compare the intensity of σ-mesons in the downward stream, $N_\sigma{}^{40°}$ with that of π-mesons in the same angular range, $N_\pi{}^{40°}$. The numbers so obtained are $N_\sigma{}^{40°} = 0{\cdot}054 \pm 0{\cdot}010$ and $N_\pi{}^{40°} = 0{\cdot}035 \pm 0{\cdot}015$. The corresponding numbers for the complete angular range are $N_\sigma = 0{\cdot}20 \pm 0{\cdot}03$ and $N_\pi = 0{\cdot}16 \pm 0{\cdot}03$. It is therefore reasonable to assume that the positively charged π-mesons, π^+, and the negatively charged heavy particles, $\pi^-(313\,m_e)$, are produced in approximately equal numbers. We should then have to regard at least the great majority of the σ-mesons in the main downward stream as particles with a strong interaction with nucleons probably produced in the roof and other neighbouring matter above the plates, for they are accompanied by π-mesons in approximately equal numbers.

Thus suppose we take the values for the number of σ- and π-mesons in the downward stream (0–40°), from the experiments both with and without lead, and assume that the number of σ-mesons, with a strong interaction, π^-, is equal to the number of π-mesons, π^+. We can then write:

$$\frac{N_\sigma(\mu^-)}{N_\rho} = \frac{N_\sigma}{N_\rho} - \frac{N_\pi}{N_\rho}.$$

Using the values given in Table 1, we thus find:

$$\frac{N_\sigma(\mu^-)}{N_\rho} = 1{\cdot}9 \pm 1{\cdot}8 \text{ per cent.}$$

Assuming, as above, that 40 per cent of the ρ-mesons are μ^--particles, it follows that only $9{\cdot}5 \pm 9{\cdot}0$ per cent of them, which stop in silver bromide, produce observable disintegrations. The results, therefore, show that most, and possibly all, the light negative mesons of the penetrating component of mass $\sim 200\,m_e$ fail to lead to a nuclear disintegration with the emission of protons and other heavy charged particles, when stopped in silver bromide.

This result depends on estimates of quantities which are not known with precision; but even if we choose the most unfavourable values, we are still led to substantially the same conclusion. Thus assume that the proportion of negatively charged particles among the ρ-mesons is only 30 per cent; and that all the

σ-mesons in the downward stream are due to μ^--particles, none being attributed to π^--particles generated in the plates and in local matter. Even with these assumptions, both of which it would be difficult to support, we must conclude that 60 per cent of the light negative mesons of the cosmic radiation, when stopped in materials of high atomic number, produce no nuclear disintegrations with the emission of heavy charged particles.

The correctness of the assumption that the numbers of positively and negatively charged ρ-mesons are approximately equal (that $\rho^+/\rho^- \sim 2{\cdot}0$, or less) has been supported by reference to the results of experiments on the penetrating component[7]. It might be objected that, in order to reduce the intensity of the soft component, these experiments are commonly made under considerable thickness of absorbing materials; and that there is no guarantee that the small values for the positive excess which are thus found will also occur under a light roof. This appears to be the weakest point in the interpretation of our results. While the preliminary measurements by the magnetic deflexion method indicate that the positive excess is, in fact, small, it is important to continue the observations in order to increase their statistical weight. It would, however, be very difficult to account for any great positive excess in terms of our present views on the nature of the processes which lead to the production of the different classes of mesons, and our conclusions would not be seriously modified if the ratio μ^+/μ^- were as great as 2.

Marshak[9] and others have considered the possibility that the interaction of a light negative meson with a nucleus may lead to the emission of a neutretto; and that the ejection of heavy charged particles from the nucleus as a result of the interaction is never, or only rarely, to be expected. Further, recent experiments[10] indicate that the capture of these mesons by lead atoms results in the emission of neutrons from the nuclei, a result which is consistent with the view that the meson interacts with one of the protons in the nucleus, as represented by the equation: $H^1 + \mu^{-1} \rightarrow n^\circ + \nu^\circ$, where ν° denotes the neutretto. Such an assumption allows us to account for the absence of the emission of heavy charged particles as a result of the interaction, for the total release of energy to be accounted for is reduced by the amount corresponding to the rest-mass of the neutretto; and it is perhaps reasonable to assume, from the principle of the conservation of momentum, that most of the balance of energy will appear as kinetic energy of the neutretto. In any case, it appears to be certain that if a light negative meson is captured by a nucleus, only a small fraction of the energy liberated by the disappearance of its rest-mass is distributed among the nucleons.

The Life-time of the π-Particles

Recently, the results of experiments on the intensity of the penetrating component of the cosmic radiation at great depths underground have been employed to obtain an estimate of the mean life-time of the heavy mesons, τ_π, and the value so obtained is 6×10^{-8} sec.[11]. The present experiments have allowed us, however, to make an independent estimate of this quantity, and we have found a much smaller value, namely, $\sim 6 \times 10^{-9}$ sec.

The new estimate is based on the following considerations: We have attributed the upward stream of ρ-mesons to μ^+- and μ^--particles formed by the decay in flight of upward moving π^+- and π^--particles which have been generated in the matter beneath the plate assembly. By comparing the number of ρ-mesons in the upward stream with that of the π-particles which have escaped decay; and by estimating the time of flight of the particles, in moving from their points of origin to the plate assembly, we can calculate the life-time of the heavy mesons.

This method depends for its success on the correctness of the assumption that the majority of the ρ-mesons in the upward moving stream are produced by the decay of π-particles; and that not more than a small proportion of them are generated directly in nuclear interactions. This view is supported by the results of the previous paper[1] which suggest that the number of μ-particles directly produced is small compared with the corresponding number of π-particles; but in order to obtain a further check, we have examined plates exposed in the ice of a glacier. In such plates, an upward moving stream of mesons can be detected, but it is now found to be composed of π-particles and ρ-mesons in roughly equal numbers. This observation proves that the number of ρ-mesons directly produced is less than that of the π-particles. We show, afterwards, that we can account for the ρ-mesons, in this case also, by decay in flight of π-particles.

In calculating the life-time, we require to know the distribution of the matter beneath the plates. The floor immediately beneath the assembly is composed of layers of various materials—granite, reinforced concrete, cork and wood—with a total weight of ~ 100 gm. per cm.^{2}. Beneath this is a number of rooms, one above the other, 2·5 m. high, with floors of weight ~ 80 gm. per cm.^{2}.

The mesons forming the upward stream are found to reach the end of their range at points which are distributed uniformly throughout the emulsions; and the energy at the point of entry into the assembly, of a meson which comes to rest in the central regions of the plates, is about 35 MeV. We therefore assume, as a first approximation, that the mesons originate in the central layers of the first floor, and come to rest in the centre of the plates; that none of the π-particles is locally produced in the plate assembly itself; and that 90 per cent of the ρ-mesons in the upward stream are μ^+- and μ^--particles.

With these assumptions we find

$$\tau_\pi = 5 \times 10^{-9} \text{ sec.}$$

We have made a more precise analysis, in which account is taken both of the generation of the mesons at different depths in the floor; and of the difference in energy, at the points of entry into the plate assembly, of those mesons which stop in different regions of the plates. This leads to substantially the same value, namely,

$$\tau_\pi = 6 \times 10^{-9} \text{ sec.}$$

It may be objected that a considerable proportion of the upward stream of mesons could have been generated at greater depths; in the lower floors of the building, for example. Such mesons must, however, have sufficient energy to penetrate the floors above their points of creation, in order to reach the plates. As a result, the relativistic contraction of the time-scale begins to play an important part. If, for example, we assume that all the mesons have been generated in the second floor, we find the following value for the life-time:

$$\tau_\pi = 7 \times 10^{-9} \text{ sec.}$$

and if generated in the third floor :

$$\tau_\pi = 8 \times 10^{-9} \text{ sec.}$$

The calculated values of τ_π are therefore rather insensitive to the assumed range of the 'primary' radiation. We take as the best value $\tau_\pi = 6 \times 10^{-9}$ sec., corresponding to the assumption that the primary radiation is reduced to an intensity $1/e$ of its original value in traversing 50 cm. of concrete. It appears reasonable to assume that the contribution to the observed backward stream made by the mesons generated in the lower floors will be relatively unimportant not only because of the absorption of the primary radiation by the overlying matter, but also because there will be a tendency for the mesons to be thrown forward in the direction of the motion of the primary radiation as their energy of emission increases.

Apart from these uncertainties, the above values must be regarded as upper limits, for some of the observed π- and σ-mesons, in the angular interval under consideration (140°–180°), will have originated in processes taking place in the plate assembly itself. Assuming that 0·03 mesons per steradian per cm.^{3} per diem are produced in this way, the calculated values of τ_π are reduced by about 30 per cent.

Returning now to the consideration of the exposures made on the glacier, it is found possible, using the calculated value of τ_π, to account for the presence of ρ-mesons in the backward stream, in spite of the much greater proximity to the plates of the matter in which the mesons are generated. The ice, which may be regarded as of indefinitely great extent, contributes a stream of π-particles with an intensity two or three times as great as that produced by the lead. It is therefore reasonable to assume that the effective thickness of the producing layer of ice, which contributes to the σ- and π-mesons stopping in the plates, is at least 110 cm. Calculations indicate that the relative numbers of π- and μ-particles observed are in agreement with a lifetime of 6×10^{-9} sec. The observations are thus consistent, in this respect also, with the assumed absence of the direct generation of μ-particles.

Alternatively, by combining the results of the two experiments—that made in the glacier, and that with the plates supported 2 m. above the floor—it is possible to obtain the following limits to the value of the life-time, without assuming that the μ-particles are not produced directly :

$$3 \times 10^{-9} \text{ sec.} < \tau_\pi < 1{\cdot}5 \times 10^{-8} \text{ sec.}$$

We believe, however, that the π-particles are alone produced directly, and if this is correct our results indicate that

$$\tau_\pi = 6 \pm 3 \times 10^{-9} \text{ sec.}$$

The present experiments were designed only as a preliminary step towards determining the life-time of the heavy mesons, and the possibility of making the present estimates only appeared during the course of the investigation. Further experiments, using a more favourable geometrical disposition, are now in progress.

Summary

The main conclusions which follow from our results may be summarized in the following terms :

(1) Observations have been made on the directions of motion, of mesons recorded by photographic plates exposed to the cosmic radiation, at their points of entry into the emulsion. The results show that there is a pronounced downward stream of ρ-mesons. The rate of arrival of these particles, and the estimated original distribution in angle of their directions of motion, before they have been scattered in the plate assembly, show that most of them are identical with the mesons of the penetrating component of the cosmic rays.

(2) Near the surface of the earth, in addition to the downward stream of mesons of mass $\sim 200\, m_e$, there is an upward stream of similar particles of considerable intensity. These particles may be regarded as being formed by the decay in flight of those π^+- and π^--particles, generated in the matter beneath the plate assembly, which are ejected upwards.

(3) Less than 15 per cent of the light negative mesons of the cosmic radiation, when brought to rest in the emulsion, produce nuclear disintegrations with the emission of heavy charged particles. It appears to be necessary, therefore, to attribute the failure to observe electrons arising from the decay of these particles, when they are stopped in materials of high atomic number, to other causes. While the results do not preclude the possibility that mesons of this type sometimes produce observable disintegrations, the low value of the upper limit for the fraction which do so leads to a strong presupposition that they always disappear through processes of another type. Taken in conjunction with the results of other experiments, our observations give support to the view that the capture of the meson leads to the emission of a neutron and a neutretto.

(4) By comparing the relative numbers of the π- and μ-particles in the upward flux of mesons, it is possible to make an estimate of the mean life-time of the heavy mesons. Assuming that the μ-particles are not directly produced in nuclear interactions, the value thus obtained is $\tau_\pi = 6 \pm 3 \times 10^{-9}$ sec.

We are greatly indebted to Mr. G. R. de Salis for assistance in making the exposures at the Jungfraujoch ; to Dr. C. Franzinetti and Dr. S. Rosenblum for kindly making available to us the preliminary results of their experiments on the determination of the sign of the charge of the ρ-mesons ; to Mr. C. M. G. Lattes and Dr. E. Gardner for the plates exposed to the mesons produced by the Berkeley 180-in. cyclotron ; and to Prof. von Muralt, director of the Hochalpine Forschungsstation Jungfraujoch, for assistance and kind hospitality. The plates exposed on the glacier were obtained in a collaboration between Mr. Y. Goldschmidt-Clermont, of the Centre Physique Nucléaire, Brussels, and three of us (U. C., H. M. and D. M.), for the purpose of determining the absorption in ice of the radiation responsible for the production of 'stars'. A full account of these experiments will be published shortly elsewhere.

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THE HUMAN MILK BANK

By EDITH G. DARE, O.B.E.
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[The first Human Milk Bank in Great Britain was established at Queen Charlotte's Hospital, London, in 1938, through the initiative and under the expert guidance of Miss Edith Dare, then the matron, with the financial assistance of the late Sir Julian Cahn through the National Birthday Trust Fund. This Bank followed closely on the heels of similar banks and bureaux in the United States (which Miss Dare visited in order to study their organisation, equipment and method of working), Germany and the U.S.S.R. The author has recently retired from her post as matron of the Hospital which she has held with distinction for twenty-eight years (she has been connected with the Hospital since 1911); but she still retains an active interest in the Human Milk Bank based at the Hospital as honorary director of the former for life. In the following article she describes the founding of the Bank, and reviews the advances made there and elsewhere since its inception.—EDITORS.]

THE Human Milk Bank at Queen Charlotte's Hospital, London, was founded in 1938—the first of its kind to be established in Great Britain. By its means, the lives of many sick babies have been saved and others have been safely brought to normal especially by supplementing the mothers' milk and assisting during periods of crisis.

Having visited several such banks and bureaux in the United States during 1938, I soon became convinced that here was a valuable social and medical service that neither Great Britain nor any other country could afford to ignore. Such a service should be established, at any rate in Great Britain, without delay. At the inception of this, the first, Bank, it was necessary to obtain funds; these were soon forthcoming from the National Birthday Trust Fund, through the generosity of the late Sir Julian Cahn. To-day, however, the Bank has succeeded in becoming entirely self-supporting; indeed it is paying its own way with a reasonably safe margin. The leading pædiatricians keenly support it; in fact, they look upon it already as an essential part of the social services of the country, especially since it is recognized by physiologists that no food other than human milk is suitable during the neo-natal period. The premature baby, the sick baby, operation cases all can benefit from the human milk so supplied. As pointed out by Dr. Martha Dynski-Klein, the "incidence of infection in infancy is estimated to be twice as high in artificially fed babies as in breast-fed ones, and the death-rate ten times as high"[1].

At the Queen Charlotte's Hospital the milk is obtained mainly from women who have been patients in the Hospital, though other women also come forward. The surplus milk is withdrawn, either by means of a breast pump, which the mother learns to manipulate herself, or manual expression is used. The mother gathers her surplus milk into a sterilized bottle which is kept in an ice box, both of which are supplied by the Bank. This is collected daily by a member of the staff of the Bank. All equipment, including sterilized towels, dishes, etc., are also supplied. Most of the donors are paid for their services.

All the surplus milk thus collected from nursing mothers (now returned to their homes) is taken to the clinic and there strained and mixed, after it has passed exacting chemical and bacterial tests. Though human milk varies somewhat in chemical content, especially in proteins and lactose, the resulting mixture has been proved to be quite satisfactory for any baby. From the mixer the milk is bottled, and then the bottles are placed in pasteurization tanks. Later, they are labelled and put into refrigerators where they are kept until required. The milk can be, and is, sent to many parts of the country, where it is required, either by special vans or train (in the latter case, special arrangements have been made for express delivery); on certain occasions even the aeroplane has been pressed into service. Queen Charlotte's Milk Bank supplies several of the leading London and provincial hospitals. A charge is usually made for the service, both to the hospitals and to individual patients; but where there is financial hardship the service is free.

To meet acute emergencies some milk is 'quick frozen' in order that it may be stored for an indefinite length of time. For this purpose 'dry ice' is used. Special moulds are placed over the 'dry ice'; into these moulds the milk is placed by means of a sterilized syringe. Another block of 'dry ice' is placed over the filled moulds, and the milk left for about two minutes to freeze. Then the disks of frozen milk are removed under aseptic conditions and kept in refrigerators until required. Such milk will keep almost indefinitely at about −10° F. Milk not thus treated, that is, milk which has been placed in the refrigerator immediately after pasteurization, will last for about forty-eight hours only. Milk which is to be 'quick frozen' must be quite fresh, that is, it must have been withdrawn from the mother on the same day that it is to be frozen.

Dr. Dynski-Klein[1] has shown by the following data that human milk which is boiled before quick cooling shows only little effective change in content, and no viable bacteria are present.

	Before boiling	After boiling
Protein	1·8–2·2 gm./100 ml.	1·5–3·0 gm./100 ml.
Fat	2·7–4·6 ,,	3·0–0·0 ,,
Lactose	5·7–6·5 ,,	6·2–7·3 ,,
Vitamin C	3·9–4·6 mgm./100 ml.	3·0–7·3 mgm./100 ml.

At her clinic, Dr. Dynski-Klein administers ascorbic acid to premature and sick babies.

The staff at Queen Charlotte's Hospital, who carry out the work of the Bank, comprise two specially trained sisters. It is their responsibility to collect milk from the mothers in their homes (two motor-cars are supplied for the purpose), and to carry out the entire routine of testing (except bacterial and chemical, which is done by an outside laboratory, which specializes in milk testing), pasteurizing, sterilizing and storing at the clinic. As much as eighteen gallons of milk have been dealt with in one week in this way. The staff, equipment and costs of a human milk bank is therefore not prohibitive considering its very wide scope, its great potentialities and its consequent importance to public health and service. To-day the Bank at Queen Charlotte's Hospital has its own Board of Governors, of which the Lord Chancellor, Viscount Jowitt, is the chairman.

There seems to be little room for doubt that the establishment of human milk banks throughout the country, organised on a county or some other regional basis, should be treated as a social and medical service of prime importance. The pioneer work done at Queen Charlotte's Hospital has now expanded so substantially as to provide a complete pilot plant or type specimen for the guidance of future banks. The space required is not great, and the staffing and other problems are of not considerable magnitude. Indeed, a human bank has already been established at Cardiff; there is a smaller unit at Manchester; another is being formed in Birmingham. There are other milk bureaux, which are usually centred in hospitals, but their services are confined to the hospital patients themselves; that is, though the human milk is obtained from mothers both within and without the hospital, it is given only to babies in the maternity wards of that hospital; and if there is any left over it is sent to the children's wards.

But much remains to be done, for even now, banks and bureaux are adversely affected by the inconstancy of supply, depending as the supply does on propaganda and the efficiency and cleanliness of the donors, to say nothing of their goodwill. Now that the National Health Service Act is in force, there are already hospital regions which might well form the necessary units on which to base new human milk banks. This point well might be considered in view of the possibility that if such banks are established over the entire country they will eventually come under the charge of the Ministry of Health through its regional or local authorities now set up under the Act.

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[1] *Brit. Med. J.*, 258 (Aug. 24, 1946).

THE BRITISH GAS INDUSTRY

THE eighty-fifth annual meeting of the Institution of Gas Engineers was held in London during June 8–11 under the presidency of Dr. Harold Hartley. It was a notable event in its history, being probably the last before the gas industry becomes integrated on a regional basis. Dr. Hartley reviewed the rise of the industry—the pioneer in the practice of distributing fuel and power as a public utility. He initiated a stocktaking of the present position and surveyed the prospects of the future. The papers presented for discussion centred round these themes. In the past, the industry experienced the advantages of competition as a stimulus to progress, not without the disadvantages of a multiplicity of independent local undertakings. For many years the need for reorganisation had been recognized. Progress in this direction had been made—some people had thought not rapidly enough. In 1943 a report of the Post-War Planning Committee of the British Gas Federation proposed geographical integration of its undertakings. This concept was eventually endorsed by the Heyworth Committee of the Government of the time. Since then the Government has decided that the desired end shall be attained by nationalization, and the necessary legislation is now before Parliament.

One cannot assess usefully the gas industry, or rather the industry of coal carbonization, apart from the supply and utilization of coal. Never was the efficiency of utilization and conservation of reserves so important. Formerly, when coal was cheap judged by present standards, and freely available, it was used as though future supplies faced no limit. Often little attention, either domestic or industrial, was paid to matters of efficiency or expenditure of labour in use. To-day the struggle to raise adequate supplies of coal to the surface is continuous. Adequacy has come to take priority over cost. One of the most effective means of meeting scarcity is to practice efficiency in use—a means promoted by the Ministry of Fuel and Power since its formation. The problems of scarcity create the most serious difficulties for public utilities, which undertake to maintain an adequate supply of a manufactured product liable to extreme and daily peaks of demand. The shortage of plant has created difficulties of a national scope for the electrical industry, difficulties only met by the shedding of load. Peak loads occur weekly in the consumption of gas; but these, owing to difference in conditions of distribution, pass almost unnoticed. To-day a new factor has come into prominence owing to the need for maintaining exports of coal. Formerly the export of coal was one only of the ample means of balancing the national budget in Britain. Now it is an indispensable means for maintaining national and international policy.

Export now obtains priority in the supply of coal, and even for the higher grades of coal. The loss of our higher grade coal—especially the best coking coal—is regrettable, although apparently inevitable at present. From the long-term point of view the consequences may be disastrous.

Every circumstance points to the need for promoting the conservation of fuel, and scrutinizing industrial practices to see how far policy or practice conforms to this need. From this point of view the papers presented at the Institute's meeting are timely. T. C. Finlayson and F. S. Townend examined critically the types of plant available to provide the supplies of coke and gas in relation to seasonal needs. Seasonal variations play a vital part in the organisation of public utilities. The gas industry requires to control the ratio of coke to gas production according to supply and consumption; but existing means to this end are only partially effective. The usual method is based on the gasification of oil, but now this is no longer adequate. Whatever the future productivity of the oil-fields, at present there is a shortage. The complete gasification of coal might make a valuable contribution to the necessary control of coke-gas ratio of production. A measure of success has been realized in Germany with the complete gasification of lignite under pressure; but so far the use of British bituminous coal has not proved serviceable. These authors conclude that "it is difficult to envisage this process as producing a therm of gas substantially cheaper than that obtained by existing methods provided that the coke can be sold". In short, there is still no certainty that costs will allow complete gasification to displace existing methods of carbonization. Linked with complete gasification of coal is the problem of distribution required to provide the 'whole-house' domestic service which is a present ideal. This might involve a tenfold increase of supply per dwelling. H. J. Escreet's survey of gas distribution is intended to examine current practice and experience with the view of finding the answer. Cost, he said, need not exceed present figures. There would, however, be a loss of the convenience given by the presence of stocks of solid fuel already distributed to meet the seasonal peak of demand for fuel. The fact is that the gas supply is a two-fuel industry, able to supply both solid and fluid fuel, and thus enjoys a unique position for dealing with the fluctuations of load caused by the British climate. If the two-fuel system persists, it points to the need for attention to the improvement of manufactured smokeless fuels and consequent conservation of high-grade coking coals.

Other papers dealt with ancillary subjects—availability of British gas coals, purification and marketing of gas and administration. At a time when everything points to the need for conserving coal and promoting efficiency in its use, the series of papers makes a valuable compilation.

H. J. HODSMAN

THE BALANCE OF RESEARCH AND TEACHING AT UNIVERSITIES

ONE session at the sixth Congress of the Universities of the Commonwealth, which was held in Oxford during July 19–23, was devoted to what is perhaps the most fundamental of all the problems which face a university: What should be the relation between teaching and research? Should one think of a university primarily as a place where learned men learn more? Or should it be a place where learned men, from their reserves of information, instruct the comparatively ill-informed? Dr. W. T. S. Stallybrass, vice-chancellor of the University of Oxford, presided at the discussion.

Prof. G. A. Currie, vice-chancellor of the University of Western Australia, introduced the topic by pointing to the very wide difference between the two concepts of a university held by Bruce Truscott, the creator of "Redbrick", and by Ortega Y. Gasset—two authors who have had considerable influence on those who are concerned with university life. Ortega Y. Gasset holds that the inquiring mind has been disastrous, that the constant, restless wish to discover has led the universities from the cultural centre of the community which is their proper place. Bruce Truscott's view is that "an urgent ferment of the mind" is the essence of a university. Unless the teachers are actively engaged in research, their teaching will be barren and unimportant. The spirit of research is the justification of a university. The two theories are diametrically opposed to each other.

None of the representatives assembled at Oxford was prepared to go all the way with Ortega Y. Gasset—though it was noticeable that two Indian representatives spoke most eloquently of the primary obligation of a university being to teach, and emphasized the harm which has been done by an ill-directed urge to publish the results of research of little value. There was general agreement that the question was, in fact, one of balancing two rival claims, each valid in itself, but each in some danger of strangling the other.

However, to say that there is a need to balance the claims of teaching and research is not to say that every university should strike the same balance. The situation, the development and the size of the university are among many factors which must be borne in mind when deciding how much time each teacher should be able to set aside for research. Similarly, the different faculties will give different answers. There was very general agreement among the scientific speakers at Oxford that it is literally impossible for a teacher of any of the scientific subjects to maintain a high standard unless he is given time for private research. Speakers from other faculties were less emphatic. But it was very clear that the need to safeguard the time of the science teachers, who are at present over-worked and over-crowded, is a very pressing need indeed.

It would be desirable to safeguard the time which a teacher should be able to give to his research by limiting the number of hours during which he or she is required to teach. But the curriculum must be so arranged as to give the teacher not merely the requisite number of hours, but also two or three days in each week when he is able to dedicate himself to research without interruption. It is obviously still more desirable to make it possible for the teacher to carry out research elsewhere if it is more convenient—which can be done only by providing sabbatical years more frequently than any universities can at present afford to do. But sabbatical years are not in themselves the solution of the problem. The teacher needs to be able to do his research concurrently with his teaching.

The problems of safeguarding the teacher's hours of research, the curriculum which makes it possible for him to carry out research, and sabbatical years—all these are administrative problems which the governing body of each university must deal with when it has decided how it proposes to balance the claims of teaching and research. The Congress at Oxford did not make any *ex cathedra* pronouncements on this problem. It was obvious that while the representatives assembled in Oxford were very conscious of the existence of the problem, they were equally clear that it is one which must be settled by each individual in each faculty. There is much research now going on which cannot be said to be of any value either to the research worker himself or to the very few students who will read the printed results. But imaginative research, undertaken, not because promotion depends upon it, but because it is a result of the researcher's enthusiasm for his subject, will make him a better teacher—and will be the more likely to be worth-while research. It is the duty of the academic administrators to make sure that they do not so overload the teacher that this type of research is made impossible.

INTERNATIONAL CONGRESS ON MENTAL HEALTH

THE International Congress on Mental Health held in London during August 11–21, was an event of considerable significance for the social sciences and psychiatry, and the repercussions will be felt far afield. It marked a stage in the struggle of these disciplines, on one hand, for acceptance among the family of sciences, and on the other, for recognition in the world of affairs. The undoubted success of the Congress springs from the marriage of these two aims. It is only possible to give here a passing reference to some of the more important aspects of the Congress, to the immense amount of preparatory work, and to the implications for the future.

The Congress comprised three separate international conferences. The first, on child psychiatry, and the second, on medical psychotherapy, were held during August 11–14; the third and main conference, on mental hygiene, during August 16–21. The Congress was organised by the National Association for

Mental Health, with Dr. J. R. Rees, formerly consulting psychiatrist to the British Army, as president. About two thousand people attended from some fifty countries.

The conferences on child psychiatry and psychotherapy were run on conventional lines. For the first conference the theme chosen was the development of personality in its individual and social aspects, with special emphasis on aggressiveness. Specific topics included aggression in relation to emotional development and in family life, psychiatric problems in education, and the community and the aggressive child.

The subject of guilt formed the theme of the second conference. This was considered under the headings : genesis of guilt, guilt and the dynamics of psychological disorder, and collective guilt. Several of the papers were of exceptional merit, notably those by Dr. John Rickman and Dr. Margaret Mead. The fourth day of this conference was devoted to advances in group therapy. Here the most interesting contribution was perhaps made by Dr. Bion, originator of the 'leaderless group' technique first used in officer selection in the British Army. In the group procedures employed by him, Dr. Bion found it important to elucidate three aspects, first, the group 'mentality' created by the anonymous participation of members ; second, the efforts of the members to achieve a full life in the group ; and third, the culture of the group.

The International Conference on Mental Hygiene was the third in a series, the first having been held in Washington in 1930, and the second in Paris in 1937. Under the broad heading of "Mental Health and World Citizenship", five topics were considered : problems of world citizenship and good group relations, the individual and society, family problems and psychological disturbance, mental health in industry, and problems of planning. The Conference had the active support of Unesco and the World Health Organisation.

In addition to the plenary sessions, there were more than twenty specialist group meetings, sponsored by such professional bodies or organisations as the Maudsley Hospital, the Institute for the Scientific Treatment of Delinquency, the Royal Society of Medicine, the Tavistock Institute of Human Relations and the British Psychological Society.

The preparations for this conference were on altogether novel lines. Indeed, the conference may be said to have begun eighteen months ago when multi-disciplined professional groups were formed all over the world to collect and evaluate available data, or carry out new inquiries, bearing on the conference topics. During the intervening period about five thousand members of the professions concerned worked in discussion groups in twenty-seven countries. Their deliberations resulted in some three hundred reports dealing with various aspects of the themes chosen for each day of the conference. About one in ten of the members of these discussion groups attended.

These groups were kept in touch with one another by a printed bulletin issued periodically. Ten such bulletins were circulated, and the contents included not only notes on the work of each of these groups, but also a critical discussion of the aims of the conference. The bulletin will continue to circulate for some time after the Congress, so as to provide an early opportunity for publishing material not to be included in the Congress Proceedings.

The three hundred reports, classified according to the five conference topics, were collated and carefully edited, and the edited material passed on to an International Preparatory Commission for further study.

In my opinion, the work of the International Preparatory Commission was the outstanding point of interest in the Congress as a whole. The primary tasks of the Commission were to examine the reports of the national study groups and to prepare a statement to serve as a basis for consideration at the conference. The Commission consisted of twenty members from ten countries and representing disciplines including psychiatry, sociology, psychology, political science, anthropology and social science. The chairman was Mr. Lawrence K. Frank (director of the Caroline Zachry Institute of Human Development). Dr. Otto Klineberg attended as representative of the Unesco project on "tensions affecting international understanding" ; and during the last two days, Dr. Brock Chisholm, director-general of the World Health Organisation, was present as observer.

The statement produced by the International Preparatory Commisssion is a document of great significance, not so much because of any original pronouncements it makes, but because it conveys the agreed views of a group of experts from many countries on issues of great moment to-day, particularly those arising out of the problem of war. The statement includes recommendations addressed to national organisations and United Nations agencies in any way concerned with 'mental health'. It is important to make clear that this term 'mental health' was not used by the Commission in any narrow sense, certainly not in the sense of a state of mind which secures immunity from certification under the Lunacy Laws. It denoted rather a state of social well-being, affecting and affected by every important aspect of the life of the individual and community.

Those who took part in the work of the International Preparatory Commission found it a unique and remarkable experience. Ample opportunity was provided to observe tensions in the making, and there were many such tensions to overcome—inter-national, inter-disciplinary and inter-personal. It is safe to say that, in my view, in this particular group the third type of tension was the most difficult to resolve. In the result, an astonishing degree of group cohesion was achieved and a wide measure of agreement on controversial issues cutting across many disciplines. The major psychological effect on the individual members was the extent of 'group involvement' which many of them experienced.

Overshadowing all other topics in the minds of the members of the Commission was the problem of mental health in relation to world citizenship, or more correctly perhaps, as Dr. Edward Glover put it, the problem of "diseases of sovereign groups". Much thought was devoted to detecting points of intervention in the vicious circle of sovereignty and preparation for war ; this is discussed in the statement.

Of special interest was the light thrown on the processes involved in an intimately co-operative intellectual effort, on the technique of approach to complex problems, on the correct division of labour between individual and group in a collective activity of this kind, and above all on the curious distorting effect of unconscious factors on reality thinking, even to the extent of blocking the recognition of the most crucial problems of all.

One triumph of the Commission was the final acceptance of the view that what is understood by the term 'mental health' is part of a system of values ; it is, in other words, a culturally determined and approved end. It required a tremendous effort to pluck out this view from the mass of anxieties, tensions and resistances which obscured it.

If the Commission made no striking new discoveries, at least it brought to light the fact that multi-disciplined thinking involves more than the mere coming together of diversely educated persons in order to exchange views. Multi-disciplined thinking may operate at many levels. In its most rudimentary form it is simply 'additive', combining the points of view of different disciplines. At a more advanced stage, it requires a new type of concept, which reflects the many-faceted situations of real life. This is one aim of operational research which is essentially a multi-disciplined activity.

The major outcome of the Congress was the formation of a World Federation for Mental Health. This Federation has already been accepted by the World Health Organisation and Unesco as a consultative body on all matters pertaining to mental health in the widest sense. The new organisation will have its roots in the professional groups formed in so many countries to prepare the way for the Congress. These groups will be strongly encouraged to broaden the base of their activities to include all the social sciences as well as psychiatry, and machinery will be devised to link all these groups with the new World Federation. In the way it is hoped to mobilize all the efforts of social scientists, in research and practice, towards the study of the most urgent human problems agitating the contemporary world.

JOHN COHEN

OBITUARIES

Dr. P. R. Lowe, O.B.E.

PERCY ROYCROFT LOWE, who died on August 18, was born at Stamford, Lincolnshire, on January 3, 1870. He was educated privately and went to Jesus College, Cambridge, where he graduated as a B.A., and afterwards qualified in medicine and surgery at Guy's Hospital, London. He served as house physician and surgeon at two hospitals in the Midlands. In 1899 he volunteered for service in South Africa and was appointed medical officer in charge of Princess Christian's hospital train. It was while he was in South Africa that he became interested in ornithology and began to make a collection. On the termination of hostilities he returned to Great Britain and a short time afterwards was appointed private physician to Sir Frederic Johnston. This was a most fortunate appointment for an ornithologist, as Sir Frederic Johnston spent the winters abroad in his private yacht and during the next six years Lowe visited the West Indies and a number of islands in the Atlantic. On these voyages he took every opportunity to study birds and brought together a collection of some three thousand skins which he later presented to the national collection. Lowe contributed a series of papers on his collections, including a study of the genus *Coereba*, in which he paid special attention to the variations in colour in that genus.

In the First World War, Lowe served in Lord Dunraven's yacht fitted up as a hospital ship, and afterwards as a captain in the R.A.M.C. in command of Princess Christian's ambulance train. In 1919 he succeeded Mr. Ogilvie-Grant in charge of the bird collection in the British Museum, and retired in 1935.

Lowe was specially interested in the anatomy and osteology of birds, and was an exceptionally careful and painstaking worker. He made a close study of the Charadriiformes, or wading birds, and published several papers on their classification based on osteological characters and colour pattern. He wrote extensively on the ostriches—both recent and fossil. His studies of the primitive characters of penguins aroused a good deal of criticism, but all will admit that his work on the microscopical structure, arrangement and moult of the feathers of these birds was of outstanding importance. For long there had been much discussion as to whether there were two species of the steamer duck (*Tachyeres*) but it was left to Lowe to prove, in 1934, that there was a volatile and non-volatile species.

Archæologists are indebted to Lowe for proving that the supposed remains of the pheasants from Roman sites in Great Britain are nothing more than the bones of domestic fowls.

It is no exaggeration to say that in the last fifty years Lowe has done more than anyone to advance the study of the anatomy of birds and their classification.

Although Lowe had always been interested in the preservation of birds, it was not until 1925 that he began to take an active part in the cause. In that year he received a letter from the late Prof. Lönnberg directing attention to the grave decline in the numbers of wildfowl in Sweden and asking his advice and assistance. He took up the matter with characteristic energy and started extensive inquiries in Britain and elsewhere. His conclusions, which were published in pamphlet form, went to show that the decline in numbers was mainly due to increased commercialization, and that unless something was done the numbers of wildfowl were bound to go on decreasing. Through his efforts the British Government was persuaded to hold an International Wildfowl Conference in 1927. A year or two earlier the International Committee for Bird Preservation had been founded, and Lowe became secretary of the British Section and for many years was chairman. His efforts in the cause of bird preservation were greatly appreciated on the Continent, and in 1938 he was elected chairman of the European Section. He was president of the British Ornithologists' Union during 1938–43 and in 1946 was awarded the Salvin-Godman Medal for his outstanding work on the anatomy of birds and his efforts in the cause of protection.

In 1924 he married Harriette Dorothy, widow of Charles Parker of Fairlee and younger daughter of the late E. G. B. Meade-Waldo. He is survived by his widow and one daughter.

N. B. KINNEAR

Dr. C. A. Elsberg

CHARLES ELSBERG, who died at his home in Stamford, Connecticut, on March 18, was one of the most distinguished neurological surgeons of his generation. When he started his career, neurological surgery did not exist as a specialty. While brain surgery was being developed by Harvey Cushing, the surgery of the spinal cord, in which Elsberg was to win international renown, was in its infancy.

The son of a merchant, Elsberg was born on August 24, 1871, in New York City—the scene of his life's work. Educated at the College of the City of New York, he graduated B.A. in 1890, and three years later took the M.D. at the College of Physicians and Surgeons ('P. and S.') of Columbia University. After serving as interne at the Mount Sinai and Sloane Hospitals, he worked under von Mikulicz-Radecki in Breslau, and on his return was appointed adjunct surgeon at the Mount Sinai. When in 1909 the Neurological Institute opened its doors at 149 East 67th Street, he was offered the post of chief of surgery, which he held until 1937. In 1929 the Institute moved to its present home (168th Street and Fort Washington Avenue) in the Columbia-Presbyterian Medical Center. Its history was told by Elsberg in 1944, in his fascinating and colourful "The Story of a Hospital", which contains a wealth of biographical and autobiographical material. He was editor of the *Bulletin of the Neurological Institute*, begun in 1931, the fifth volume of which was dedicated to him on his sixty-fifth birthday.

In 1917, at the request of the Surgeon-General, Elsberg organised the New York Neurosurgical School for Medical Officers of the American Army, of which he became military director.

His more important writings include "Experimental Investigation of the Treatment of Wounds of the Heart by Means of Suture of the Heart Muscle" (1898), which was translated into many languages, and the classic "Surgical Diseases of the Spinal Cord, Membranes, and Nerve Roots" (1941), which was a revised edition of "Diseases of the Spinal Cord" (1916) and of "Tumors of the Spinal Cord" (1925).

Many honours came Elsberg's way: he was president of the American Neurological Association and of the Society of Neurological Surgeons, and his name is associated with the operation of drainage in syringomyelitis (also known as Pussep's operation). An inspiring teacher—he was very popular as professor of neurological surgery at 'P. and S.' (1921–37)—he was distinguished and youthful in appearance, charming in manner, deeply cultured, and he radiated energy and enthusiasm.

W. R. BETT

Mr. J. S. Dow

MR. JOHN STEWART DOW died on August 12. He was born in 1881. After passing through a course in electrical engineering at the City and Guilds of London Engineering College he was for some years on the staff of the College and was later engaged on research work, chiefly on photometric problems.

His early association with Leon Gaster led to the first publication in 1908 of *The Illuminating Engineer*, on which he acted as assistant editor. Since 1928 he had been editor, the name of the journal having been changed to *Light and Lighting* in 1936.

Mr. Dow was even better known for his unbroken connexion with the Illuminating Engineering Society since its foundation in 1909 when he was honorary assistant secretary. In 1928 he became honorary secretary, a position he held until he became president in 1946. After his term of office as president, he continued to serve on the Council of the Society, and during the whole thirty-nine years he was present at every Council meeting. He was a fellow of the Society, and in 1942 was elected an honorary life member, an honour which was shared only by the late Mr. A. P. Trotter.

He was a member of the Departmental Committee on Factory Lighting and of the Illumination Research Committee, as well as of the Lighting Committee of the Building Research Board and numerous other committees concerned with lighting.

He was honorary secretary of the Association of Public Lighting Engineers from 1931 until the end of 1935.

His life's work for the Illuminating Engineering Society cannot be over-valued. He always avoided publicity; but it is due to his work and foresight that the Society has reached its present position. He will be deeply mourned by all associated with lighting matters.

NEWS and VIEWS

New British Association President: Sir John Russell, O.B.E., F.R.S.

AT the British Association meeting just held at Brighton under the presidency of Sir Henry Tizard, Sir John Russell was elected president for the 1949 meeting at Newcastle-upon-Tyne. Sir John has a world-wide reputation as an agricultural scientist. He joined the staff of the Rothamsted Experimental Station in 1907, and succeeded the late Sir Daniel Hall as director in 1912. He retired in 1943, the year of Rothamsted's centenary. During his thirty-one years as director, there was a remarkable expansion of Rothamsted's activities. Various new departments were added, new buildings were erected, and the finest agricultural library in Great Britain, if not in the world, was built up. He also raised the necessary funds for the purchase of the Rothamsted Farm and the Manor House. Sir John has made outstanding contributions to soil science and is the author of several standard works on that subject. He is a former president of the International Society of Soil Science, a foreign associate of the Paris Academy of Sciences, and a member of numerous other academies. Among the distinctions he has received are the Messel Medal of the Society of Chemical Industry and the Albert Medal of the Royal Society of Arts. During the Second World War he was adviser to the Soviet Relations Division of the Ministry of Information and chairman of the Agriculture Sub-Committee of U.N.R.R.A.

Sir John is the first agricultural scientist to become president of the British Association. He has regularly attended the meetings for more than forty years and was the first recorder of agriculture when that subject was a sub-section of botany. Agriculture was made an independent Section in 1912 and Sir John was president of it in 1916 at Newcastle, in 1924 at Toronto and, again, at the centenary meeting in London in 1931. He has served several periods as a member of Council and has been chairman of various committees and a president of the Conference of Delegates of Corresponding Societies. Sir John has travelled widely and has made a special study of agriculture in the U.S.S.R. and Poland. He is about to visit Poland again to take part in the jubilee celebrations of the Academy of Arts and Sciences and will represent the British Association there. He will also give lectures and visit agricultural research institutions on behalf of the British Council.

British Association: Exhibition of Scientific Instruments

One of the many interesting features of the Brighton meeting of the British Association was a display of the latest scientific instruments, and particularly of electronic equipment, arranged by the Scientific Instruments Manufacturers Association of Great Britain in the Corn Exchange. The stands were well set out in the ample space available, so that visitors were not subjected to the crowding so often occurring at such exhibitions. In opening the exhibition on September 13, the president of Section A, Sir Lawrence Bragg, paid tribute to the enterprise of instrument manufacturers in organising the display at a time when they were actively engaged in participating in the British Exhibition in Copenhagen. He stressed the importance of accurate, and often very elaborate, instruments both in modern scientific research and in the industrial field. The research worker, he said, has outlived the days of home-made apparatus largely constructed of jam-jars and sealing-wax and has become more and more dependent upon the skill of the instrument maker; and it is necessary for the two to work hand in hand to secure progress. There was a time, and that not long ago, when the scientific world looked mainly to the United States and Germany for the most accurate instrument work, but to-day Great Britain can hold its own in every section of instrument making, and in many it leads the world; in this sphere, at least, Britain no longer fears foreign competition. On the following morning, the whole session of Section A was given up to a symposium on instrumentation and control, including industrial applications of electrical devices, opened by Sir Ewart Smith.

Museum of Archæology and Ethnology, Cambridge: Dr. G. H. S. Bushnell

Following the resignation of Dr. T. T. Paterson, Dr. G. H. S. Bushnell has been appointed curator of the Museum of Archæology and Ethnology, Cambridge. Dr. Bushnell is the son of the Rev. D. G. S. Bushnell; he was educated at Wellington and Cambridge, taking his degree in 1925; recently (1947) he obtained the degree of Ph.D. In July 1926 he went to Ecuador as a geologist with Anglo-Ecuadorian Oilfields, Ltd., and remained there with intervals of leave until 1938. It was while working in Ecuador that archæology first attracted his attention, and he examined the southern part of the coastal plain, which up to then had never been studied. He also travelled in Peru, visiting Lima, the Cuzco region, etc., and began to write up the results of his investigations. During the War he held a commission in the Royal Engineers. While an important work is still in the press awaiting publication, there have been numerous articles from Dr. Bushnell's pen on such subjects as an archæological collection from Macas in Ecuador east of the Andes in Oran, and reviews, etc., in various learned journals. Dr. Bushnell is on the Councils of the Society of Antiquaries and the Royal Anthropological Institute. As a keen student of medieval archæology he has also been appointed vice-chairman of the Chelmsford Diocesan Advisory Committee for the Care of Churches. From every point of view Dr. Bushnell should make an ideal curator, for he has considerable personal charm and can arouse enthusiasm in others.

Mathematics in King's College, Newcastle-on-Tyne:

Dr. A. E. Green

On the retirement of Prof. G. R. Goldsbrough, the chair of applied mathematics at King's College has been filled by the appointment of Dr. A. E. Green. Dr. Green obtained distinction at Cambridge in Part III of the Mathematical Tripos, was a Smith's Prizeman and research fellow of Jesus College. Since 1939 he has held the post of lecturer in mathematics at the Durham Colleges. Dr. Green's published work mainly covers the subjects of hydrodynamics and elasticity. In the former he has dealt with the production of small eddies from large ones, the gliding of a plate on a stream and the fluctuations of pressure in a turbulent fluid. In elasticity he has investigated the stability of thin twisted strips and corrugated plates, and numerous problems in the stress systems of æolotropic plates.

Dr. W. W. Rogosinski

The chair of pure mathematics at King's College, vacated by Prof. A. C. Offord on his appointment to the chair at Birkbeck College, has been filled by the election of Dr. Werner W. Rogosinski. Dr. Rogosinski studied at the Universities of Breslau, Freiburg and Göttingen. At the last-named he proceeded to the degree of doctor of philosophy in 1921. He held the appointment of *Privatdozent* and later *Ausserordentliche* Professor at the University of Königsberg. In 1937 he came to Great Britain and did some teaching at Cambridge. Later he was appointed assistant in the Mathematics Department of the University of Aberdeen and in 1945 lecturer at King's College, University of Durham, where he was further raised to the status of reader in mathematical analysis in 1947. Dr. Rogosinski has written numerous papers on trigonometric series, Dirichlet's series and problems of complex analysis. He also published "Fouriersche Reihen" (Sammlung Schubert, 1930), and, with the late Prof. G. H. Hardy, the Cambridge Tract on "Fourier Series".

Nicolas Copernicus

In an article in *The Times* of September 7 on "Poland's Northward Thrust", reference is made to Thorn (now Torun) Allenstein (renamed Olsztyn) and Frauenburg (now Frombork), the three places, in what was formerly East Prussia, in which Copernicus lived and died. To-day the district is a scene of destruction unparalleled elsewhere in Europe. Torun, where Copernicus was born, became Polish after the First World War, and Olsztyn, where he lived for a time, and Frombork, where he worked and died, are now also Polish. In Olsztyn castle, fortunately undamaged, one can see the chamber occupied by Copernicus when he was a canon and administrator of his uncle's diocese; and at Frombork, a small town completely ruined by the War, is the house he lived in and the cathedral in which he was buried. The Polish Government has given a sum of money towards restoring the old quarters of Copernicus in the cathedral close and his tower and observatory. Of the body of Copernicus, however, no trace can be found. "It appears," says the article, "that shortly after the Russians entered Frombork, unknown vandals raided the coffins of bishops and noblemen buried under the cathedral on the basis of a report that many of them wore gold and diamond rings."

Ontario Research Foundation

In his annual report for 1947 to the chairman and governors of Ontario Research Foundation (43 Queens Park, Toronto 5), the Director of Research refers to the virtual completion of the extension of the main building and to a considerable expansion of the scientific and administrative staff. During the year a new Industrial Research Services Department was established particularly to help the numerous small industrial units of the Province, and the Department is expected to handle about two thousand inquiries a year. The Chemistry Department prepared a comprehensive report for the Minister of Mines on the processes in operation for the removal of sulphur gases from smelter fumes ; fellowships were concerned with emulsion inks, waxes and transparent paper, sulphite liquor, the manufacture of carboxymethylcellulose, and the polymerization systems butadiene – styrene, butadiene – isoprene and isoprene – styrene. In the Department of Engineering and Metallurgy, sixty-seven investigations were undertaken on behalf of various firms, and fellowships on the influence of chemical composition and physical structure of forged steel balls and their resistance to wear during grinding, and on wire rope, and work on the economics of ferrous smelting in Ontario continued. The Department of Parasitology carried further its work on the life-histories and the factors influencing the activity of black flies and leucocytozoon infection in ruffed grouse and other birds, especially domestic ducklings. Several drugs used successfully in combating malarial infection in man gave negative results on infected birds.

The Physiography Department is completing a study of the geological history of southern Ontario, has co-operated with the Department of Agriculture in a chemical investigation of pasture grasses, and has assisted the Meteorological Service of Canada in equipping and supervising twelve new weather stations at selected points. The work of the Textiles Department has been handicapped by shortage of staff and accommodation ; but the Courtaulds (Canada) Ltd. fellowship has continued its work on dye formulæ and methods of finishing and the development of consumer standards, while under the Canadian Industries Ltd. fellowship, in addition to developing fabric construction to meet the demands of the consumer, the behaviour of the nylon fibre under different physical and chemical conditions is being investigated. Some progress is also reported by the Department in investigations on the transmission of water vapour through fabrics, the physical properties of nylon and the factors involved in removing oils used as lubricants after processing textile materials.

Barton's Ruling Engine

In the possession of the Science Museum, London, there are six beautifully engraved buttons, classified as diffraction gratings, which are still regarded as masterpieces. They were the work of Sir John Barton, deputy comptroller of the Royal Mint in the early part of the nineteenth century, about whom little is known personally, but who must have been an ingenious inventor and capable engineer, for in 1806 he invented a differential screw measuring instrument capable of measuring to 10^{-5} inch. In 1822 he was granted a patent for his engraved buttons. After Sir John's death the ruling engine on which the buttons had been ruled passed into the possession of his grandson and then to his great-grandson, Mr. R. V. Barton, who, in 1925, presented the engine, together with some handwritten notes of his father's concerning the working of the machine, to the Science Museum. The above details are given in a valuable and interesting illustrated article entitled "A Ruling Engine Used by Sir John Barton—and its Products" which P. Grodzinski, the technical editor of the *Industrial Diamond Review*, contributes to the February number of that journal. It would appear that this is the first authoritative description.

From his inspection of the machine and relevant documents, Grodzinski concludes that the engine was not Barton's own design but is probably a Harrison straight-line engine. The machine itself is made of brass except for the screws, spindles and pivots, which are steel. The tools are of well-ground steel ; but diamond tools, generally octahedral Brazilian stones with curved edges, are provided. Six engraving tools work on six specimens simultaneously, and the method of movement of the tools is ingenious, kinematically sound, and simple. It is fully described in the article, with clear diagrams and photographs. The high precision of division and the engraving of six specimens at once are the special merits of this machine.

Tables of Uranus for the Period 4000 B.C.–A.D. 3000

MM. M. Kamieński and R. Walter have a paper with this title (*Extrait Bull. de l'Acad. Polon. Sci. et Lettres*, 1947) which provides a simple and rapid method for finding the heliocentric co-ordinates of Uranus, the perturbations of the other planets having been taken into consideration in the compilation of the Tables. An explanation of the method for applying the Tables is given, and an accuracy of about 1′ is obtainable, which is sufficient in a great many cases. The Tables should prove very useful, especially in investigating the influence of Uranus on the motions of comets in ancient times, though, of course, they will prove helpful in many other cases as well. Special investigations were made of the long-period inequalities of Uranus, and it seems that these, namely, those of the mean longitude, the eccentric angle, longitude of perihelion, and semi-major axis, can be approximately represented by a Fourier interpolation formula. These inequalities are so regular that the corresponding formula for perturbations in longitude can be extended even beyond the limits of the Table, for the period 6500 B.C.–A.D. 5500, with a mean error of less than 1′.

Conference on Experimental Biology, Peiping

More than one hundred teachers, research workers and senior students in biology of the universities and institutions of Peiping met in the new campus of the College of Agriculture of the National Tsinghua University during July 17–25. The instigator of the conference was Dean P. S. Tang, ably and generously assisted by his colleagues of the College. The campus is next to the famous Summer Palace which was freely accessible to the members during this conference, and one of the most enjoyable parts was the boating at night on the lake inside the Palace. Preliminary meetings consisted of lectures on the place of biology in ancient Chinese history, and on the teaching methods of biology in colleges and high schools. So many contributed valuable suggestions to the latter subject that a special committee was appointed to explore further this important and fertile field. The regular programme consisted of symposia and lectures on recent advances in genetics, hormones, nutrition, viruses and rickettsia, biophysics and aviation physiology. The round-table meetings were attended chiefly by senior members, and the following topics were discussed: cytology, growth and development, immunity, and effect of temperature on organisms. The general impression of the conference was that the time allotted to each speaker was too short, and plans are being made to choose one or two important subjects as the theme of the conference next summer. It was fortunate that the Peiping branch of the Chinese Society of Phytopathology was able to meet with the conference on the afternoons of July 20 and 21.

Hallucinations

THE *Proceedings of the Society for Psychical Research* for July (48, Pt. 175) has a suggestive and highly critical article by the research officer, Dr. D. J. West, in which he examines afresh the evidence hitherto collected by the Society for the supernormality of such spontaneous phenomena as precognitive dreams, apparitions and other forms of hallucinations. In the case of the precognitive dream Dr. West concludes that a perfect case has not yet been printed in the Society's publications. "There is always a flaw somewhere," he writes, adding that "the perfect case is a myth" (p. 271). In dealing with the crisis apparition, he points out that numerous and unsuspected sources of error abound, and he indicates his dissatisfaction with the evidence on which those conducting the famous Census of Hallucinations were inclined to rely. Finally, he points out how better evidence could be secured if witnesses could be persuaded to forward their results immediately to some independent source, so that adequate inquiries might be forthwith made and the original documents preserved for subsequent examination and verification.

New Fungi of Madras

A NEW species of discomycete fungus, *Bulgariastrum tumifaciens*, which causes galls upon living leaves and inflorescences of *Capparidis sepiariæ* is described by T. S. and K. Ramakrishnan (*Proc. Ind. Acad. Sci.*, 27, B, 2; Feb., 1948). This is one of seven new species named by the same authors in their most recent additions to the purely indigenous fungus flora of Madras.

Culture Collections of Micro-organisms

As a result of a recommendation of the Specialist Conference of Culture Collections of Micro-organisms held in London in August 1947 under the auspices of the Standing Committee of the British Commonwealth Scientific Official Conference (1946), national committees were established in the several Dominions and in the United Kingdom for the co-ordination of the activities of existing collections of micro-organisms and to assist in the preparation of collection catalogues. The United Kingdom National Committee will deal also with the Crown Colonies. As a first step in this work, national committees are circulating a questionnaire to all laboratories in their areas at which collections of micro-organisms are known or believed to be maintained. Inevitably some such collections will be missed, particularly those in private hands. Owners of collections of micro-organisms in the United Kingdom and Crown Colonies who have not received a questionnaire are asked to notify Dr. Martin Ware, secretary of the United Kingdom National Committee, at the Medical Research Council, 38 Old Queen Street, Westminster, London, S.W.1.

Installing of Electric Discharge Lamps

DEVELOPMENTS in electric discharge lamps and the very rapid increase in their application have produced an urgent requirement for the revision of Section 8 of the Regulations for the Electrical Equipment of Buildings issued by the Institution of Electrical Engineers. A new edition, the twelfth, of the Regulations is at present in preparation; but to meet this immediate need Revised Section 8, "The Installing of Electric Discharge Lamps", has been produced and supersedes, as from July 1, the corresponding section of the eleventh edition. Fluorescent tubes operating at normal mains voltage become, for the first time, a subject of specific requirements under Section 8*A*, which covers all discharge lamp installations in which the open-circuit voltage does not exceed 650 volts. Section 8*B* gives additional requirements for high-voltage installations up to 5,000 volts to earth, which is the maximum voltage permissible.

Colonial Services Appointments

THE following appointments in the Colonial Services have been announced: E. S. Porter, agricultural officer, Kenya; H. C. Butcher, chemist, Federation of Malaya; A. R. Giles, land surveyor, Hong Kong; A. L. Griffith, temporary forest officer, Zanzibar; R. A. Neve, specialist, Agricultural Department, Gold Coast; A. G. A. Sutton, Government geologist, Mines Department, Trinidad; R. H. Wharton, medical entomologist, Federation of Malaya; J. G. M. King (agricultural officer, Tanganyika), director of livestock and agricultural services, Basutoland; H. S. Purchase (senior veterinary research officer, Kenya), chief veterinary research officer, Kenya.

Royal Society Scientific Information Conference

A SUMMARY of the recommendations of the Scientific Information Conference held during June 21–July 2 has now been issued to delegates; they will be included in the report of the Conference which is now in preparation. The Council of the Royal Society considered these recommendations on July 8, and agreed to receive them. In one of the recommendations the Conference invited the Royal Society to consider setting up a standing committee on scientific information services, and the Council has agreed in principle to do this.

Announcements

A REFRESHER COURSE on "The Mechanical Working of Metals" is being organised by the Institution of Metallurgists and will be held at Ashorne Hill, Leamington Spa, during the week-end beginning October 1. Among those giving lectures are Dr. Hugh Ford, Dr. R. Genders, Dr. E. Orowan, Dr. L. B. Pfeil, Prof. H. W. Swift and Prof. F. C. Thompson.

A FINE CHEMICAL GROUP of the Society of Chemical Industry, for "the discussion of fine chemicals, especially those of therapeutic or biological interest", has been formed. Meetings are to be held monthly, and the opening address will be delivered by Prof. J. H. Burn, on "Fine Chemicals for Medical Use", at the Royal Institution, London, W.1, on October 5. The chairman of the Group is Sir Jack Drummond, and the honorary secretary is Dr. W. Mitchell, Messrs. Stafford Allen and Sons, Ltd., Wharf Road, London, N.1.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Application of Paper Partition Chromatography to the Separation of the Sugars and their Methylated Derivatives on a Column of Powdered Cellulose

THE analysis of mixtures of sugars resulting from the hydrolysis of a polysaccharide has been greatly facilitated by their separation[1] and quantitative estimation[2] on the paper chromatogram[3]. The application of this technique to the analysis of mixtures of sugars from methylated polysaccharides[4] has simplified a task previously difficult, which involved the fractional distillation of the methyl glycosides and examination of the fractions obtained. The latter method suffers from two disadvantages, in that it requires large quantities of methylated polysaccharides, and that it is very difficult to obtain a complete separation of the methyl glycosides.

The paper chromatographic technique now offers a rapid method of separating and estimating the sugars quantitatively as well as giving a strong indication as to their identities. The final proof of their constitution, however, still depends upon their separation and identification by determination of their physical constants, and the formation of characteristic derivatives. With this in mind we have attempted the separation of the sugars and their methylated derivatives on a column of powdered cellulose, a method similar to that tried by Synge[5], who used a column of potato starch, and similar to that employed by Bell[6], who used a column of silica gel. Using a column of cellulose (Whatman ashless filter tablets, rubbed through an 80-mesh sieve and tightly packed, as a powder, in a tube of 12 in. length and 1¼ in. diameter) and with *n*-butanol saturated with water containing 1 per cent of ammonia as the mobile phase, we have separated two- and four-component mixtures of sugars with individual recoveries of 95–100 per cent. The column is purified by washing it with the solvent until the eluate is non-reducing; this ensures that all the soluble impurities have been washed from the cellulose and that equilibrium is reached between the cellulose and the solvent. The maximum weight of any component sugar that can be placed on this column is proportional to its R_G value[4], and is of the order of 200 mgm. for galactose. The syrupy mixture of sugars to be separated is placed on the top of the cellulose and the solvent allowed to percolate down the column. At half-hourly intervals the receiver collecting the eluate is changed automatically. The time taken for any particular sugar to emerge is inversely proportional to its R_G value and is approximately 15 hr. for 2 : 3 : 4 : 6-tetramethyl glucose.

To determine which sugars are present in the receivers, a small spot from each is placed, in order of time, on the starting line of a paper chromatogram, and the sugars separated in the usual manner. On revealing the position of the sugars on the chromatogram by development with ammoniacal silver nitrate, a picture of the distribution of each sugar among the receivers is obtained. From such a chromatogram one may decide which portions of eluate to take in order to obtain a chromatographically pure sample of sugar. While such high recoveries as 95 per cent are quite practical where the components differ widely in R_G values, it is frequently expedient, where one has several components of closely similar R_G values with consequent overlapping of the sugars, to be content to divide the receivers in such a manner as to lead to a lower percentage recovery of a pure fraction. The ease of separation decreases as the R_G values of the particular sugars increase.

By use of the method described above, we have separated in the pure state and in yields of 95 per cent a two-component mixture consisting of *L*-rhamnose (300 mgm.) and *L*-arabinose (200 mgm.) and a four-component mixture consisting of *L*-rhamnose (50 mgm.), *D*-ribose (50 mgm.), *L*-arabinose (50 mgm.) and *D*-galactose (50 mgm.). The isolation of pure crystalline specimens of *L*-rhamnose hydrate and *D*-galactose and of *L*-rhamnose hydrate and *D*-xylose from *Sterculia Setigera* gum and from linseed (Var. Redwing) mucilage respectively has also been achieved.

Methylated sugar beet araban, on hydrolysis, yields in equimolecular amounts 2 : 3 : 5-trimethyl *L*-arabinose, 2 : 3-dimethyl *L*-arabinose and 2-monomethyl *L*-arabinose[7]; pure specimens of each of these sugars have been obtained by use of the above method.

The application of the above technique to the separation and identification of the hydrolysis products of various methylated polysaccharides will be the subject of a later publication.

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J. K. N. JONES
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May 13.

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Oxidation of Ferrous Ions in Aqueous Solution by X- and γ-Radiation

THE oxidation of ferrous ions in dilute sulphuric acid solution by X- and γ-radiation has attracted attention since the work of Fricke[1,2] as a possible method of integral dosimetry for aqueous media[3]. A study has now been made which confirms that the rate of oxidation with dose is essentially independent of the concentration of ferrous ions in the region 10^{-3} to 10^{-4} *M*, and which also shows that this rate is maintained independently of the wave-length of the radiation over a much wider range of wave-length than has hitherto been used in studies of this type.

Four different types of system were employed.

(i) An ionization chamber was constructed of 'Perspex' with graphite electrodes and connected to a D.C. amplifier circuit, and a 'Perspex' irradiation cell was made of identical geometry to the chamber to contain the solution under investigation. The cell and chamber could be interchanged on a stand which was kept in a constant position relative to the tube of an industrial X-ray unit operating at 200 kV. peak and 10 m.amp. The thickness of the cylindrical internal volume of the cell and chamber was only 3·23 mm. In another similar system where this volume was 9·75 mm. in thickness, the yields observed were about 30 per cent lower, due to the absorption of the X-rays in the solution.

(ii) Another ionization chamber and cell combination due to Dr. A. J. Cipriani was used. In this case the ionizing volume was in the form of a thin annulus round a central cylinder containing a 2-curie radium bomb. Cell and chamber were made of polystyrene, and the whole enclosed in a large block of lead.

In both these cases the ionization current in the chamber at saturation passed through a high resistor of known value to ground. The voltage above this resistor was estimated by a null method in both cases, a modified Lauritsen electroscope being used in system (ii). By showing that the ionization current was proportional to the area of the collecting electrodes, and by reversing the polarity of the electrodes, the effect of stray ionization currents was found to be small in both cases.

(iii) A set of stands, 3 in. in height, was placed inside a lead enclosure 18 in. square. On one of the stands was placed a 600 mc. radium capsule, and on another a cylindrical cell containing the solution. By using different combinations of stands the mean distance between source and solution could be varied between 3·7 cm. and 7·6 cm. The radiation intensity at the various positions was measured using a 100-*r*. 'Victoreen' condenser-type chamber with a 5 mm. thick 'Perspex' cap to ensure equilibration of the primary radiation with its secondary electrons.

(iv) A 'Pyrex' cell was constructed with a central thimble in which a glass tube containing a 1,200-mc. capsule of radium could be inserted. The cell could be attached to a vacuum apparatus and evacuated in order to ascertain the effect of removing all dissolved air. No dosimetry was attempted in this system, the purpose here being to compare the oxidation-rate of aerated and evacuated samples, as was done by Fricke[2] and Shishacow[4]. It was found during these experiments that very little oxygen was necessary to saturate the solution effectively with oxygen from the radiation chemical point of view. For example, a solution equilibrated with cylinder nitrogen containing about 2 per cent of oxygen was oxidized within a few per cent of the rate at which an oxygen-equilibrated solution was oxidized. This was true for the small doses used, none of which was higher than 13,000 r.; but at much higher doses one would expect a change of oxidation-rate of solutions initially saturated with air[1,4]. When the solution was evacuated hard for 20–30 min., the oxidation-rate fell sharply to less than one-half of its previous value, as was found by Fricke[1] and Shishacow[4]. The amount of water which evaporated during evacuation was not significant if the solution were made up to its original volume before analysis, as the oxidation-rate has been repeatedly shown to be independent of concentration of ferrous ions within much wider limits[1,2].

The water used in making up the solutions was redistilled successively from alkaline potassium permanganate and alkaline manganous hydroxide, and the solutions were made up with ferrous ammonium sulphate, the ferrous ion concentration varying between 10^{-3} and 10^{-4} M, depending on the dose to be administered. All were made 0·8 N in sulphuric acid, at which acidity the effect of the ammonium ions was found to be negligible. This acidity was used in order to effect comparison with earlier work. In less acid solutions the reaction is much more complex[5]. The concentration of ferrous ions was followed by potentiometric titration with $N/5{,}000$ ceric sulphate solution. The rate of change in absence of radiation was negligible during the time occupied by an experiment when the solution was stored in the 'Perspex' cells. Before irradiation, the samples of solution were equilibrated with nitrogen containing a small but constant percentage of oxygen, and the cells were filled in this atmosphere.

The results obtained in these various systems will be presented in detail later. Expressed as the number of atoms of ferrous ion oxidized per 32·5 eV. expended in the solution[6], the ionic yields for solutions containing dissolved oxygen lay between 4·9 and 6·0 in every case, the average value being 5·5. From the ratio of the yields in aerated and evacuated solutions obtained in system (iv) above, the average ionic yield for oxygen-free solutions was found to be 2·2.

Recalculation of the values obtained by Fricke and Shishacow in earlier work[1,2,4], reveals a substantial degree of agreement between the three sets of investigations:

	M/N (32·5 eV.) aerated	M/N (32·5 eV.) air-free
Fricke (refs. 1,2)	5·9	2·3
Shishacow (ref. 4)	5·2	2·0
Present work	5·5	2·2

The above results establish that higher ionic yields than 2·2 observed in solutions of this type which are either not de-aerated at all or are equilibrated with cylinder nitrogen can be ascribed to the presence of dissolved oxygen. The cause of this enhancement is very probably to be associated with the formation of the hydroperoxide radical HO_2 in the reaction $H + O_2 \rightarrow HO_2$, which converts the reducing fragment H formed in the primary act on irradiation of water into an oxidizing agent.

I wish to express my thanks to the National Research Council of Canada and the Ministry of Supply for the use of experimental facilities, and to Dr. A. J. Cipriani, Mr. F. H. Krenz, and Prof. W. V. Mayneord for valuable discussions and assistance in connexion with dosimetry.

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May 26.

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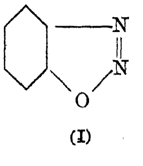
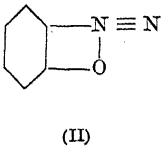
Diazo-Oxides

In relation to work recently summarized[1], we have under investigation a number of diazo-oxides. Certain of those theoretically derived from *o*- and *p*-aminophenols (and their derivatives) are included. Satisfactory formulations for these have been debated for



(I)



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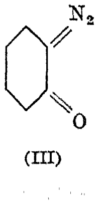
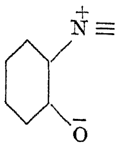


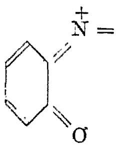
(III)

years[2,4]. Earlier writers proposed structures involving rings, such as I[3,4] or II[5], or quinonoid forms, such as III[6]. Hodgson and Marsden[2] conclude, however, that both the *o*- and the *p*- series are best regarded as resonance hybrids of the type

$$\bar{O} - C_6H_4 - \overset{+}{N} \equiv N \longleftrightarrow O = C_6H_4 = \overset{+}{N} = \bar{N}.$$

If such a view were correct, it is obvious from IV and V qualitatively that, while the polarity of a *p*-diazo-oxide *could* be small, that of its *o*-isomer should be large, and—in proportion as the ionized form predominates—approach that of a true 'zwitterionic' molecule[7]. Thus the dipole moment of IV is unlikely to be less than *c*. 10*D*, while V, on reasonable analogies, might be so low as 4*D*.


(IV)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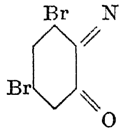
(VI)

Although we have not been able to prepare the unsubstituted parents IV or V, dipole moment determinations on representative derived members of both the *o*- and the *p*-series are now nearing completion. Results are proving close to those expected for V (that is, also III); for example, μ (found) for VI is 2·9*D* (calculated, about 3*D*). Ultra-violet spectroscopic evidence is in the same direction.

Very little contribution from fully dipolar forms seems, therefore, to be occurring. We make this preliminary communication because we note that dipolar structures for the *o*-diazo-oxides have been adopted recently by Vaughan and Phillips[8] to explain stability measurements.

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May 18.

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Preparation of Nitrogen-free Sulphuric Acid

Of the various methods suggested for the preparation of sulphuric acid suitable for use in nitrate estimations, the method of Atkins[1] is perhaps the most suitable. There is, however, one disadvantage in this method, namely, the precipitation of sulphur if a slight excess of hydrogen sulphide is added. This not only takes a long time to settle, but also interferes with the estimation, often giving lower values due to the presence of traces of sulphur dioxide.

Various alternative methods were tried in this laboratory for the preparation of a suitable sample of sulphuric acid for the estimation of nitrates in sea-water by the reduced strychnine method of Denigès. A good procedure seems to be to treat about 250 ml. of concentrated sulphuric acid (ordinary quality) with 6–10 drops of 40 per cent formalin solution in a 500 ml. Kjeldahl flask, and to boil the mixture until it is decolorized. It is possible to prepare about a litre of good acid in the course of a couple of hours by using a series of flasks. The acid so prepared gives an almost colourless reagent with reduced strychnine.

This method is, therefore, suggested as an alternative where difficulty is experienced in the preparation of acid according to Atkins' method.

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Decay and Capture of Slow Mesons in Dielectrics

Conversi, Pancini and Piccioni[1], and others[2], observed decay electrons from positive mesons coming to rest in solids of either light or heavy elements. For negative mesons, however, decay electrons were found in light elements only; for heavy elements it is generally assumed that negative mesons are captured by atomic nuclei before they can decay. The absence of capture of positive mesons can be understood as being due to the influence of Coulomb repulsion[3]; its absence for negative mesons in light nuclei has led Fermi, Teller and Weisskopf[4] to the conclusion that the interaction between nuclei and mesons is much weaker than was assumed hitherto. These authors show that it takes less than 10^{-12} sec. for a meson to reach an energy of about 1,000 eV., where its velocity is about equal to that of electrons in outer orbits, that is, 10^8 cm./sec. They then consider that the meson quickly loses its remaining energy, reaching the *K*-orbit of an atomic nucleus in about 10^{-12} sec. It should then be captured by the nucleus in about 10^{-18} sec. if current ideas of interaction between mesons and nuclei are correct. In doing so they have, however, considerably overestimated the energy transfer from slow mesons to electrons[5]. In the present communication reasons are given for believing that in dielectrics the time required by a meson to reach a *K*-orbit is longer than estimated by Fermi *et al.*, but that it would be very difficult to decide from theoretical considerations whether this time may be of the same order as the decay time ($\sim 2 \times 10^{-6}$ sec.).

Mesons with a velocity less than about 10^8 cm./sec. (kinetic energy $< 1,000$ eV.) transfer energy to electrons (the velocity of which is greater than 10^8 cm./sec.) at a very low rate (at least in non-metals) because the electrons can follow nearly adiabatically. (This would not hold for free electrons. Even metal electrons are not entirely free, and it seems, indeed, that their deviation from free electrons largely determines inelastic scattering. For, in view of the screening of the meson charge, the collision is of very short duration; development of the effective meson field into a Fourier series will lead mainly to high-frequency terms. The electrons then behave as bound, as for their optical properties.) However, in this region, down to an energy of about 0·1 eV., the rate B of loss of energy to the lattice vibrations is considerable. In ionic crystals, in particular, with residual frequency $\omega_i/2\pi$, it has been shown[6] that:

$$B = C\,\frac{e^2\omega_i^2}{v}\,\log(v/\omega_i a),$$

where $C \sim 1$, v is velocity of mesons and $a \sim 10^{-8}$ cm. In other types of solids a similar order of magnitude may be expected. Hence the time to slow down a meson from an initial velocity $v_i \sim 10^8$ cm./sec. to a final velocity $v_f \ll v_i$ is

$$\int_{v_f}^{v_i} \frac{\mu v dv}{B} \sim \frac{\mu}{10}\,\frac{v_i^3 - v_f^3}{e^2\omega_i^2}$$

(μ is mass of a meson), which is about 10^{-11} sec. if $\omega_i \sim 10^{14}$ sec.$^{-1}$. The above formula holds practically throughout the whole continuous spectrum of the meson. As soon as the discrete spectrum has been reached, with a distance of more than $\hbar\omega_i$ between energy-levels (or rather energy-bands), energy transfer to the lattice vibrations becomes very improbable, because it would involve simultaneous emission of many quanta, $\hbar\omega_i$. In this range either radiative loss or loss due to the Auger effect should be predominant.

The latter was estimated[7] on the assumption that the highest discrete levels should have large quantum numbers and high angular momentum corresponding to nearly circular orbits with radius of about half a lattice distance. Larger orbits would lead to a continuous energy spectrum, whereas penetrating orbits (low angular momentum) would lead to much stronger binding. On the above assumption, emission of an electron (in dielectrics) must be connected with a considerable transfer of angular momentum, which leads to very much smaller transition probabilities than in the ordinary electronic Auger effect. An estimate of the time t_A required for emission of an electron[7] (whereby the reaction on the meson was neglected) gives

$$t_A \sim 10^{-18}\frac{r}{r_e}\left(\frac{v_e}{v}\right)^3 \exp\left(\frac{r}{r_e}\;(\alpha\,\frac{v_e}{v} + 2)\right) \text{sec.}$$

Here r and r_e are the radii of the mesonic and electronic orbits, v and v_e are the respective velocities and $\alpha \sim 3$. One would expect $v_e/v \sim (\mu/m)^{1/2}$ to be approximately 15.

Although the above formula is based on a simplified model, it serves to show the extreme sensitivity of t_A to the exact value of $rv_e/r_e v$. Thus if, for example, $r = r_e$ and $v_e/v = 6$, then $t_A \sim 10^{-8}$ sec. If, however, $v_e/v = 8$, then $t_A \sim 10^{-4}$ sec.

To estimate the radiative loss it should be possible to treat the meson on a classical basis. Then the rate of loss of energy is approximately $e^2r^2\omega^4/c^3$. Assuming the meson to move in a Coulomb field with effective charge $\overline{Z}e$, it is found that $r^2\omega^4 = e^4\overline{Z}^2/\mu^2 r^4$. Hence the time required by the meson to reach an orbit with radius r_f—starting with an initial radius r_i—is approximately

$$\frac{\mu^2c^3}{\overline{Z}e^4}\,(r_i^3 - r_f^3) \sim \frac{\mu^2c^3r_i^3}{\overline{Z}e^4}$$

if $r_f^3 \ll r_i^3$. Assuming $r_i \sim 10^{-8}$ cm.$\sim h^2/me^2$, the time for radiation loss is about

$$t_R \sim \frac{1}{\overline{Z}}\left(\frac{\mu}{m}\right)^2\left(\frac{hc}{e^2}\right)^3 \frac{h^3}{me^4} \sim \frac{10^{-6}}{\overline{Z}}\text{sec.}$$

It thus appears that energy loss due to the Auger effect is extremely sensitive to the properties of the highest bound meson orbit. In contrast to the assumptions made by others[4], it cannot be excluded that in dielectrics it plays only a negligible part compared with radiative loss, which leads to times of the same order as the natural decay time.

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Relation between the Masses of Mesons

Starting from Jeannine Viard's results[1] based on the notion of 'solide principal' in wave-mechanics, and from Eddington's considerations on fundamental frames, we are in agreement with Mme. P. Destouches-Février's principle[2] called the 'principle of respective frames': "All that concerns the actions of observers must be linked to a mean frame; all that concerns the objective properties of particles must be linked to a geometrical frame". It results that the laws of direct action between electrons and photons or between nucleons and mesons, which are actions of contact according to Dirac's δ-function, appear for the observers to obey a Gaussian distribution law with standard deviation σ; the self-energy of one particle in a field is then finite. σ is determined by the assumption that the mass of the electron originates entirely from an electromagnetic energy; thence

$$\sigma = \sqrt{\frac{2}{\pi}}\,\frac{e^2}{m_e c^2} = 5{\cdot}627 \times 10^{-14}\text{ cm.}$$

The self-energy of a nucleon in a mesonic field depends on the mass of mesons. For a given value of this self-energy, there are generally several values of masses. Mme. P. Destouches-Février[3] has proposed a 'principle of associated particles': "Each type of interaction between the particles of a C-kind being expressed by means of particles of spin 1 or 0, is such that one particle of C-kind has a well-determined self-energy $\mathfrak{E}_C$, in the field associated with particles of spin 1 or 0. When, for a given value $\mathfrak{E}_C$, there are several values of masses μ for the particles associated with the field such that $\mathfrak{E}(\mu) = \mathfrak{E}_C$, then the different particles are existing and playing a part in the suitable description of the interaction under consideration; in addition, the existing values of μ are in the neighbourhood of a minimum of the function $\mathfrak{E}(\mu)$".

If we study the function $y(\mu) = \mathfrak{E}(\mu)e^2/g^2$ (where g is the mesonic charge), as M. Cazin[4] has done, we find that $y(\mu)$, for μ increasing from 0, starts from the value m_ec^2 of the self-energy of the electron, and decreases to a minimum at approximately $0{\cdot}365\ m_ec^2$ reached for $\mu \cong 255\ m_e$, then increases to a maximum at about $6\ m_ec^2$ reached for μ slightly less than $800\ m_e$, then decreases to a minimum at about $1{\cdot}8\ m_ec^2$ reached for $\mu \cong 1{,}000\ m_e$.

Admitting the principle of the associated particles, two mesons play a part in the nuclear forces of masses m_μ and m_π, corresponding to the same $\mathfrak{E}_C$-value of the self-energy of a nucleon in the mesonic field; and we have $m_\mu < 255\ m_e$, $m_\pi > 255\ m_e$.

From the $y(\mu)$-function, we can draw the curve giving m_μ as a function of m_π (see accompanying table).

m_μ/m_e	m_π/m_e	m_π/m_μ	$y(\mu)/m_ec^2$
0	407	∞	1
100	364	3·64	0·657
108	360	3·33	0·631
127	350	2·75	0·578
158	331	2·09	0·500
164	329	2·06	0·489
176	320	1·82	0·46
180	318	1·76	0·447
188	313	1·66	0·434
189	312	1·65	0·432
192	310	1·61	0·427
200	305	1·525	0·412
202	304	1·5	0·408
207	300	1·45	0·401
212	297	1·40	0·395
225	284	1·26	0·377
240	270	1·125	0·368
250	260	1·04	0·367
255	255	1	0·365

According to the experimental results reported by Occhialini and Powell[5], Gardner and Lattes[6] obtain $m_\pi = (313 \pm 16)\ m_e$. From the above table, we derive $m_\mu = (188 \pm 24)\ m_e$ and $m_\pi/m_\mu = 1{\cdot}66 \pm 0{\cdot}26$. From the results of Goldschmidt, King, Muirhead and Ritson[7], $m_\pi = (270 \pm 40)\ m_e$; we derive from our table $255\ m_e < m_\pi < 310\ m_e$; $192\ m_e < m_\mu < 255\ m_e$; $1 < m_\pi/m_\mu < 1{\cdot}61$. From the results of Lattes, Occhialini and Powell[8] $m_\pi/m_\mu = 1{\cdot}65 \pm 0{\cdot}15$; we derive from our table $m_\pi = (312 \pm 8)\ m_e$ and $m_\mu = (189 \pm 13)\ m_e$.

These three experimental results agree with the relation between the masses m_μ and m_π given by the principle of the associated particles. The value m_π for the artificial mesons obtained by Gardner and Lattes agrees perfectly with the experimental value of m_π/m_μ for the cosmic mesons obtained by Lattes, Occhialini and Powell; this last determination gives the most accurate results.

So it seems that the nuclear forces may be interpreted as due to mutual exchanges of mesons of the two types. Their spins would be 1 or 0. No arbitrary constant has been introduced and the difficulties of divergence have been removed. Finally, the $y(\mu)$-curve and the principle of the associated particles leads to the possibility of the existence of two particles of spin 1 or 0 and of masses more than 900 m_e; one of these particles may be identified with that found by Leprince-Ringuet; these particles correspond with forces of a type different from ordinary nuclear forces.

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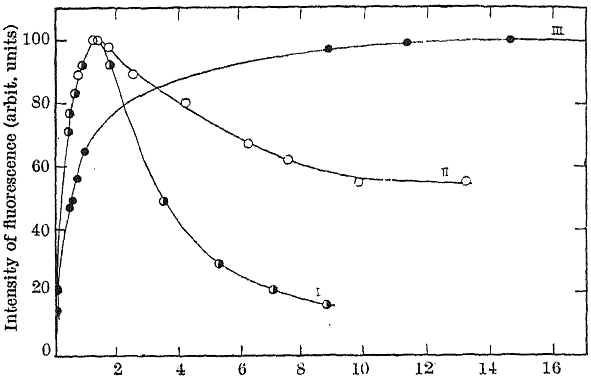
Concentration Quenching of Fluorescence in Chlorophyll Solutions

IN a paper concerned chiefly with the results of measurements of the self-quenching of the fluorescence of solutions of aromatic hydrocarbons[1], Weiss and Weil-Malherbe report a few measurements on the self-quenching of ethyl chlorophyllide solutions. They conclude from these latter results that it is unnecessary to postulate the existence of a long-lived form of excited chlorophyll. This conclusion has been shown by E. Rabinowitch[2] to be inconsistent with the observed[3] high quantum yields for chlorophyll-sensitized photo-oxidation. More recently, the same author[4] has pointed out that the value of the quenching constant obtained by Weiss and Weil-Malherbe is too large to be consistent with the number of encounters between chlorophyll molecules as calculated from kinetic theory.



Curve I: (moles/l.) × 4·75 × 10^4; curves II and III: (moles/l.) × 10^4

A comparison of the quantitative data[5] on the absorption and fluorescence spectra of chlorophyll solutions indicates that the mistake in the work of Weiss and Weil-Malherbe is their disregard of the reabsorption of the fluorescent light. Unfortunately, their report does not contain sufficient experimental detail to permit a computation of the effect of reabsorption upon their results. In particular, they do not specify the nature of the colour filter used in front of their photocell, the wave-lengths present in the incident light, or the ratio of the concentrations of chlorophyllides *a* and *b* present in their sample. For these reasons and because their claims have a direct bearing upon possible mechanisms for photosynthesis, it seemed worth while to repeat their measurements[1] under controlled conditions.

The accompanying graph shows the Weiss and Weil-Malherbe data for ethyl chlorophyllide (curve I) and our data for the fluorescence intensity, obtained by two different methods, of chlorophyll *a* in ether. Since the fluorescence intensities are expressed in arbitrary units, these have been adjusted to make all three maxima identical. For convenience in plotting, the concentration scale for curve I differs from that used for curves II and III.

In the experiments corresponding to these latter curves, the incident light was monochromatic, of λ 4358 A., and the intensity of the fluorescent light was measured with a photocell (Photovolt Corp. Mod. 500). The solutions were made up from freshly prepared chlorophyll *a* and dry ether, and were evacuated to remove oxygen.

The data plotted as curve III were obtained by a method which was designed to eliminate the effect of the reabsorption of the fluorescent light. A colour filter (Wratten Infra-red 88), transmitting only that wave-length region of the fluorescent light which is not detectably absorbed by chlorophyll *a* solutions, was placed in front of the photocell. To minimize further spurious effects of changing concentration, a thin layer (2 mm.) of solution was used, and the photocell faced the side of the cuvette upon which the exciting light was incident. The results obtained under these conditions demonstrate that the self-quenching of the fluorescence of chlorophyll is negligible at all concentrations up to 10^{-3} M (a concentration ten-fold greater than the highest value published by Weiss and Weil-Malherbe). Similar results were obtained with chlorophyll *b* and with solutions in acetone and in methanol.

In an attempt to duplicate the results of Weiss and Weil-Malherbe, the Wratten infra-red filter in front of the photocell was replaced with one (Corning 246) which is transparent to the fluorescent light of all wave-lengths but which absorbs λ 4358 A. The photocell was placed "in line with the light source", that is, behind the cuvette. Curve II represents the measurements made in this manner. The measured intensities show the expected effect of reabsorption of the fluorescent radiation by the chlorophyll solution. The reabsorption is not so great in this case as in the measurements of Weiss and Weil-Malherbe, the difference most probably being due chiefly to the different thicknesses of the cuvettes used, and to the fact that solutions of pure chlorophyll *a* (or *b*) were used in our experiments.

We may conclude, therefore, that the effect of self-quenching of the fluorescence (as distinct from possible self-quenching of long-lived excited states) of chlorophyll (and presumably chlorophyllide) solutions is negligible under conditions in which photochemical and optical measurements have been made on these solutions.

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Polarization of the Raman Line of the Totally Symmetric Vibration of Stannic Chloride

It is well known that the depolarization factors of the Raman lines produced by the totally symmetric vibrations of the XCl_4 molecules of the tetrahedral type are not zero[1]. Recently in this laboratory, it has been shown that the depolarization factors are smaller than the results given by many investigators; but they definitely are not zero[2].

Cabannes and Rousset[3] have pointed out the fact that this residual depolarization could be caused by the isotopes of chlorine, and that a measurement of the depolarization factors of the individual lines due to the various isotopic molecules would decide this point. Welsh, Crawford and Scott[4] have shown that the intensity of the Raman line due to totally symmetric vibration of stannic chloride ($SnCl_4$) is about six times greater than that of the corresponding line of carbon tetrachloride (CCl_4); Langseth[5] has shown that the former gives the same type of isotopic structure as the latter.

Development of the method of polarized incident light[2] for determining depolarization factors, plus availability of a spectrograph suitable for fine-structure investigations[6] along with a newly developed powerful light source having suitable spectral characteristics[7], have made the above-mentioned fine-structure investigation a practical possibility for stannic chloride.

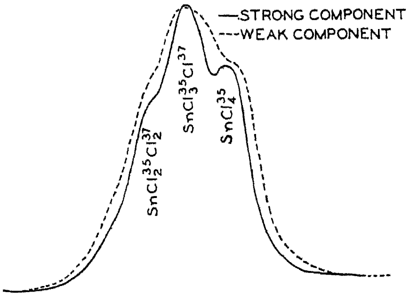
The 'weak' and 'strong' polarized components of the totally symmetric vibration of stannic chloride have been photographed using this high-dispersion spectrograph. The exposure time for the 'weak' component was 48 hr. and for the 'strong' component about 10 min. Microphotometer curves for the two components are reproduced herewith. From inspection of the microphotometer curves it is at once apparent that there is no sensible change in the relative intensities of the isotopic components in the two traces. It is also apparent that the fine structure is almost obliterated in the weak trace due to a broadening of the fine-structure components. The cause of the broadening is definitely not instrumental, since grating ghosts are equally sharp on the 'weak' and the 'strong' plates.

The 'weak' component of the Raman line due to the totally symmetric vibration of carbon tetrachloride is not sufficiently strong to be photographed on the high-dispersion spectrograph. However, if the lack of symmetry of the isotopic molecules is the cause of the residual depolarization, the centre of gravity of the line should be appreciably shifted on a photograph made with the 'strong' and 'weak' components in juxtaposition. This experiment was performed with carbon tetrachloride, using a fast prism spectrograph with excellent defining power (dispersion 30 A./mm.). No noticeable shift of the centre of gravity was observed. The results of these experiments show the following:

(1) The depolarization factors in the three isotopic molecules of stannic chloride are identical within the precision of measurement (better than 0·002). There is reasonable evidence to suggest that the same is true for carbon tetrachloride.

(2) A considerable part of the observed depolarization arises from a small fraction of the total intensity of the line; this small fraction has an intensity distribution different from that of the strong polarized component.

Apart from these experiments, there is evidence to suggest that the isotopes of chlorine cannot cause the finite depolarization factor. When one chlorine atom is replaced by an atom as heavy as bromine or as light as hydrogen, the depolarization factor of the corresponding vibration remains very small. Therefore, judging purely on the basis of the masses involved, the effect of a chlorine isotope should be negligibly small.



Microphotometer traces of the 'strong' and the 'weak' polarized components of the Raman line due to the totally symmetric vibration of $SnCl_4$

One can find at least two possible causes for the small residual depolarization. First, the interaction between the molecules in the liquid may be sufficient to cause both the residual depolarization and the observed broadening of the weak component. Secondly, in the XCl_4 type of molecules, at room temperature a large fraction of the molecules are not in the ground-state but in the degenerate vibrational levels. It is possible that some slight interaction between these modes of vibration may cause the residual depolarization.

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Tilted-Plate Compensators

W. A. P. Fisher has recently described[1] a tilted-plate compensator which employed a plate of *CR* 39 resin in place of the usual calcite or quartz. This substitution permitted the development of apparatus of large aperture, although the material is not quite uniform and needs to be rather thick, so that the possible effect of lateral displacement must be considered.

I wish to direct attention to the suitability of lepidolite for the construction of tilted-plate compensators of large field. This material, which is a uniaxial variety of mica, cleaves at right angles to the optic axis and is practically colourless in the thicknesses needed for the production of convenient retardations. The use of such cleavage plates avoids the grinding and polishing required in the case of calcite or quartz and also the difficulties associated with the employment of *CR* 39 resin, including that of the possible variation of calibration with time. The axis about which the lepidolite is tilted lies in the plane containing the leading direction for the magnetic vector.

The following experimental results were obtained with white light using a plate of lepidolite the thickness of which was 0·245 mm. The angle of tilt was observed on a dial graduated in units of 1·8° and the readings have been converted to degrees. Values calculated by means of an approximate theoretical formula are included in the table.

Observed path-difference (λ)	0·5	1·0	1·5	2·0	2·5	3·0	3·5	4·0
Angle of tilt (°)	19·31	27·18	33·93	39·87	45·00	50·04	54·18	58·86
Calculated path-difference (λ)	0·50	0·98	1·50	2·03	2·52	3·04	3·47	3·95

For a plate of thickness t tilted through an angle θ in air, the length of the light path is $t/\cos\varphi$, where $\mu\sin\varphi = \sin\theta$, μ being the refractive index of the material and φ the angle of refraction.

The equivalent path-difference is $(\mu_1 - \mu_2)t/\cos\varphi$, μ_1 and μ_2 being the two refractive indices.

$$\mu_1^2 - \mu_2^2 = K\sin^2\varphi, \; K \text{ being a constant}^2,$$

$$\therefore \mu_1 - \mu_2 = (K/2\mu)\sin^2\varphi. \quad \mu_1 + \mu_2 = 2\mu, \text{ very nearly.}$$

The equivalent path-difference

$$= (K/2\mu)(t\sin^2\varphi)/\cos\varphi$$
$$= (K/2\mu)\,\{(t\sin^2\theta)/\mu^2\}\,\{\mu/(\mu^2 - \sin^2\theta)^{1/2}\}$$
$$= (At\sin^2\theta)/(\mu^2 - \sin^2\theta)^{1/2}, \; A \text{ being } K/2\mu^2.$$

Application of the method of least squares to the experimental results above shows that $At = 6{\cdot}939$ or $A = 28{\cdot}32$, and that $\mu^2 = 2{\cdot}389$. These values were used in calculating the results given in the last line of the table.

Muscovite may also be used in the construction of a tilted-plate compensator of limited range. Tilting about the trace of the plane containing the optic axes causes the retardation to increase until it reaches four times the normal value at an inclination of about 70°. Tilting about a perpendicular axis causes a decrease to zero at an inclination of about 35°.

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Thorium and Uranium Content of the Velence Mountains, Hungary

There are few areas in Hungary where the occurrence of thorium and uranium minerals is theoretically possible. We investigated during the summer of 1947 the mountains near Lake Velence near the town of Székesfehérvár in Hungary.

Portable battery-operated Geiger–Müller counting equipments have been constructed at this Institute. One of them served in connexion with headphones for a qualitative search only. It was easily portable in a small case and weighed (including built-in batteries suitable for 400 counting hours, high-voltage supply and headphones) less than 5 kgm. The other counter-set possessed an electromagnetic impulse-counter, a more powerful amplifier, and was supplied by a motor-car starter battery (12 volts, 70 ampere-hours) by means of vibrating alternators. The Geiger–Müller counters were of brass, 45 mm. outer diameter, 1·8 mm. wall thickness and 88 mm. length, and were of the self-quenching type, filled with argon and alcohol vapour.

We observed a considerable γ-activity everywhere in the acid eruptive rocks of the area investigated over an area of about 30 km.², which exceeded the intensity of the cosmic radiation (40 impulses per min.) by a factor of 2–3, when the counter was placed immediately on the rocks.

In one case we drove in a boring about 50 cm. deep into the granite wall. We observed an activity of 260 impulses per min., with the counter in the boring. We evaluated this result quantitatively, taking into account the self-absorption of the γ-radiation within the rock, by calibrating the counter with the γ-radiation of thorium in radioactive equilibrium with its decay-bodies. To do this we placed a known amount of thorium (in equilibrium) at a measured distance from the counter and determined the number of impulses per min. The soft components of the γ-radiation were retarded by the thick wall of the counter and by 2 mm. of lead. Calculation shows that the concentration (c) of the radioactive material per gram rock substance, expressed in 'thorium-γ-equivalents', can be calculated from the following expression, approximately :

$$c \approx \frac{\mu J}{A.4\pi.\rho},$$

where μ is the coefficient of the self-absorption per cm. in the rocks, J is the number of impulses counted per min., A is the rate of counting per min. when 1 gm. of thorium is at 1 cm. distance from the counter (as determined above), ρ is the specific density of the rock.

We obtained in this way an approximate value for the concentration in thorium-γ-equivalents, $c = 0{\cdot}12 \times 10^{-3}$ gm. thorium equiv. per gm. rock. About the same order of magnitude of activity was observed everywhere in the acid eruptive rocks (granite, aplite, granitporphyre, etc.). On the other hand, basic eruptive rocks (andesite) and rocks of hydrothermic origin (quartzite) were found to be practically inactive.

Typical samples of the rocks mentioned were removed and tested carefully in the laboratory of the Institute. We checked at first the share of potassium in the γ-counting-rate. The potassium content of the rocks amounted to 3–4 per cent K_2O [1]. We mixed potassium nitrate to an inactive quartz powder in amount equivalent to 4 per cent K_2O content and found that the observed activity remained at about the level of statistical errors, and could be made responsible for no more than 10–15 per cent of the activity of the investigated eruptive rocks.

For the determination of the origin of the activity, Dr. M. Vogl-Földvári brought samples of the rocks into complete solution, and we determined the equilibrium radon content of the solutions by means of a calibrated emanometer. The equilibrium thoron content was determined under steady gas circulation, because of its short half-life. The calibration of the emanometer for thoron was carried out exactly in the same way, with the same velocity of gas circulation, using a small known dissolved amount of very old thorium nitrate. The accompanying table shows the results.

Rock sample, place	gm. U/gm. rock	gm. Th/gm. rock
Granite from Velence	$0{\cdot}87 \times 10^{-5}$	$4{\cdot}2 \times 10^{-5}$
Granite from Nadap (rich in biotite)	$0{\cdot}86 \times 10^{-5}$	$4{\cdot}0 \times 10^{-5}$
Aplite from Nadap	$0{\cdot}80 \times 10^{-5}$	$5{\cdot}6 \times 10^{-5}$

The acid eruptive rocks of the Velence Mountains everywhere contain similar concentrations of thorium and uranium, namely, about 8–9 gm. uranium per thousand kgm. rock and 40–60 gm. thorium per thousand kgm. rock. It seems doubtful whether so small a concentration will be of any use, unless very cheap concentrating processes should be found. It is of importance, however, that this thorium and uranium content makes possible the exact determination of the age of the rocks.

No concentrated deposits or ores were found during this preliminary survey.

A detailed publication (also in English) will appear in the *Transactions of the Hungarian National Geological Institution*, Budapest. I am indebted to the Hungarian National Geological Institution and to the Hungarian Ministry of Industry and Mining for supporting this investigation, and to Dr. A. Földvári, chief geologist of the Institution, for geological advice during this survey.

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Maxwell's 'Fish Eye' as an Ideal Electron Lens

THE most famous optical medium furnishing a perfect optical image formation is the well-known 'fish eye' of Maxwell[1], the refractive index of which $n(r)$ is given by the spherical distribution

$$n(r) = A/(a^2 + r^2), \tag{1}$$

where A and a are constants. The trajectories are circles. Other media with ideal image formation have been found by W. Lenz[2], and they are of the form

$$n(r) = A/r \left[\left(\frac{r}{a}\right)^p + \left(\frac{q}{r}\right)^p\right] \quad (p = 1, 3, 5, \ldots). \tag{2}$$

The most obvious way of analogous construction of an ideal electron lens would be the realization of the corresponding potential

$$V(r) = \frac{A^2}{(q^2 + r^2)^2}, \text{ or } V(r) = \frac{A^2}{r^2\left[\left(\frac{q}{r}\right)^p + \left(\frac{q}{r}\right)^p\right]^2},$$
$$(p = 1, 3, 5, \ldots), \qquad \text{(3 and 4)}$$

by a spherical or axial symmetrical distribution of space charge[3]. This method is technically impossible, however, in the present state of development.

But limiting ourselves to plane image formation, an ideal electron lens could be constructed by a set of axially symmetrical metallic electrodes without space charge, which in a plane $z = z_0$ perpendicular to the axis must produce the potential distribution (3) or (4). We shall show in the following that such an electron lens can be constructed.

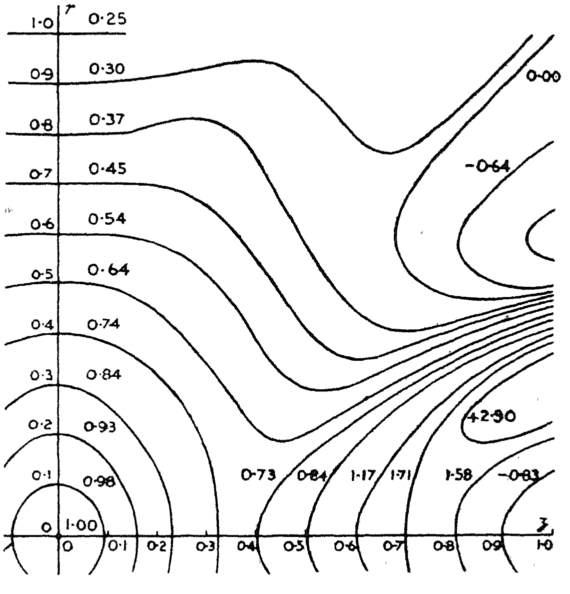
The general solution of the differential equation for an axially symmetrical potential is

$$\varphi(r,z) = \int_0^\infty C(k) J_0\,(ikr)\,(c_1 e^{ikz} + c_2 e^{-ikz})\,dk. \tag{5}$$

The function $C(k)$ can be determined by means of Hankel's integral theorem[4] in such a way that for $z = z_0$ (for example, $z_0 = 0$) the potential will be $V(r) = A/(a^2 + r^2)$. We get

$$\varphi(r,z) = -\frac{iA^2}{2a} \int_0^\infty J_0\,(irk)\,K_1\,(iak) \cos kz \,.\, k^2 dk, \tag{6}$$

where $J(irk)$ is the Bessel function of the order zero, and $K_1(iak)$ the so-called Macdonald function of the



first order (see, for example, G. N. Watson, l.c, p. 78). Since one finds,

$$\int_0^\infty J_0\,(ikr)\,K_1\,(ika)\,k^2dk \;=\; \frac{2ia}{(q^2+r^2)^2}, \qquad (7)$$

it can be easily shown that (6) is indeed that solution of $\Delta\varphi = 0$, which has for $z = 0$ the form (3). The shape of the electrodes might be calculated from $\varphi(r,z) = \text{const.}$

But more important than these formulæ of the potentials required is development in series, by means of which we are able to calculate them numerically. One finds for the general form of the potential having the required distribution in the plane $z = 0$ the expression

$$\varphi(0,r) \;=\; V(r) \qquad (8)$$

$$\varphi(r,z) = \sum_{\nu=0}^{\infty} (-1)^\nu \frac{(\nu\,!)^2\,2^{2\nu}}{(2\nu)\,!}\, z^{2\nu} \sum_{\mu=0}^{\nu} \frac{V^{(\nu+\mu)}_{(r^2)}}{(\mu\,!)^2\,(\nu-\mu)}\, r^{2\mu}, \qquad (9)$$

and this becomes in our case (3)

$$\varphi(r,z) \;=\; \frac{1}{(1+r^2)^2} \sum_{\nu=0}^{\infty} (-1)^\nu\; b_{2\nu} \left(\frac{2z}{(1+r_2)}\right)^{2\nu}, \qquad (10)$$

in which the $b_{2\nu}$ are the following polynomials

$$b_{2\nu} \;=\; \frac{(\nu\,!)^2\,(\nu+1)}{(2\nu)\,!} \sum_{k=0}^{\nu} (-1)^k \binom{\nu}{k} \binom{\nu+1}{k} r^{2k}. \qquad (11)$$

Since for (9), $\left(\frac{\partial\varphi}{\partial z}\right)_{z=0} = 0$, the force on the electron perpendicular to the plane $z=0$ vanishes, that is, the electron having the initial velocity in the plane $z=0$ stays in this plane. My collaborator, H. Robl, has worked out these formulæ, and the surfaces $\varphi(r,z) = \text{const.}$ are represented in the accompanying graph. It is imagined to be rotated about the z-axis. It is only necessary to imitate two of the equipotential surfaces at the top and below and on the sides by metallic electrodes in order to have the required potential distribution in the plane $z = 0$, where all (circular) trajectories from a point are exactly focused to an image point. It is possible to show by means of Larmor's theorem that a uniform magnetic field can also be combined with the electric field. Such a perfect cylindrical lens might be especially useful for a velocity-spectrometer, since only particles of the same velocity are focused to the same point; and perhaps (combined with a magnetic field) it might also be applied in mass-spectrography. In order to improve the stability of the electron trajectories in the plane $z = 0$ it will be necessary to investigate also the other potentials of the type (4) found by Lenz, for a suitable exponent p.

A discussion of this subject will be given shortly in the *Acta Physica Austriaca*.

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[1] Maxwell, J. C., "Scient. Pap.", 1, 74–79 (Solutions of Problems). For further literature, see Czapski, S., and Eppenstein, O., "Grundzüge der optischen Instrumente nach Abbe", 213–216 (Leipzig, 1924). Boegehold, H., on absolute optical instruments. Caratheodory, C., *Sitzber. d. Akad. d. Wiss., Munchen*, 1 (1926).

[2] Lenz, W., in "Problems of Modern Physics" (edit. by P. Debye for A. Sommerfeld's 60th Birthday, 198 (Leipzig, 1928).

[3] Gabor, D., *Nature*, **150**, 650 (1942); *Electronic Eng.*, **15**, 295, 328 and 372 (1942–43). See also Cosslett, V. E., "Introduction to Electron Optics", 142 (Oxford, 1946). Gabor maintains in the above-mentioned papers that the ideal electron lens of Maxwell type (3) is unique in the three-dimensional case; this is in contradiction with the result (4) of Lenz. For the two-dimensional case, however, Gabor states that the solution (3) is not unique.

[4] Watson, G. N., "A Treatise on the Theory of Bessel Functions", 453 (Cambridge, 1944).

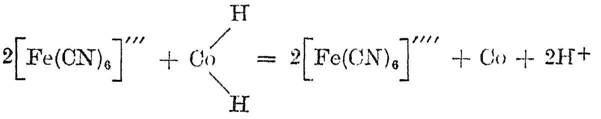
Source of the Hydrogen Ions in Gastric Juice

A FLOW of water from the oxyntic cells through a membrane permeable to chlorine ions and limited in its cation permeability to hydrogen ions should result in a secretion of hydrochloric acid in accordance with the view of Hollander[1]. It can be shown, however, that under such conditions the concentration of hydrogen and chlorine ions in the secretion would be of the order of 10^{-3}–$10^{-4}\,N$, and unless we add further hypotheses, including relatively very large water reabsorption, it would seem necessary to suppose a primary concentrating of hydrogen ions within the cell. It would appear that the simplest manner in which this could be achieved is by way of an organic acid produced metabolically or in relation to metabolic activities, hydrolysis of esters and the like. From the data of Davies *et al.*[4] showing that under their conditions Q_{HCl} can be greater than Q_{O_2}, the view was entertained that the organic acid might be cyclically reformed or restored[3].

From our studies with yeast[5] and the high acidic formation resulting from exchanges of potassium and hydrogen ions, a further stepping up of the hydrogen ion concentration could occur by exchange of hydrogen ion for an inorganic cation.

It may be pointed out that one of the catalysts involved in the passage of metabolic hydrogen to oxygen could conceivably function as such an acid, and the purpose of the present communication is merely to indicate such a possibility, which further exemplifies our previous hypothesis in which phosphoglyceric acid was used as an illustration.

It may be noted that in the metabolism of 1 molecule of glucose, 24 hydrogen atoms pass to oxygen, 12 from the original carbohydrate molecule and 12 from water incorporated at various stages. The metabolic hydrogens can be regarded as converted at some stage into electrons and free hydrogen ions. This does not happen at the stage of the pyridine nucleotides, but appears to happen at or before the stage of the cytochromes. It is of interest to note that Quastel[6] has used the reaction:



$$2\left[\text{Fe(CN)}_6\right]''' + \text{Co}\begin{matrix}\diagup\text{H}\\ \diagdown\text{H}\end{matrix} = 2\left[\text{Fe(CN)}_6\right]'''' + \text{Co} + 2\text{H}^+$$

to determine the concentration of cozymase, by measuring the acidity produced, through its effect on bicarbonate.

If all the metabolic hydrogens were utilized to supply the hydrogen ions of the gastric juice, the upper limit of the ratio Q_{HCl}/Q_{O_2}, from this source alone, would be 4.

When the electrons pass to oxygen, hydrogen ions are in turn withdrawn from the cell. Ordinarily the addition and withdrawal quantitatively balance without alteration of pH from such exchanges; but it may be possible that the stage of hydrogen ion formation can be effectively separated in the oxyntic cell from the stage of withdrawal. Such might occur, for example, if the donation of hydrogen atoms and conversion to hydrogen ions and electrons took place at a surface with fixed enzyme units of the donator and free diffusion back, through the cell, of the electron carriers.

Such amplifications of our earlier view had been entertained here prior to the appearance of a communication to the Biochemical Society (April 1948) of Davies and co-workers, in which they refer to a hypothesis of Crane, Davies and Longmuir (to be published), and which "requires that H atom transport by dehydrogenating enzymes is part of the mechanism by which H ions are secreted".

Upon inquiry, it would appear that this hypothesis does not include the supposition that the metabolic hydrogen atoms supply directly the hydrogen ions of the gastric juice in the manner indicated above, and which is an extension of a possible mechanism we had previously put forward[3]. Such would largely simulate the production by the yeast cell of a *p*H as low as 1·5 in the suspending fluid, and due to free hydrochloric acid.

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April 26.

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An Antigen Related to the *ABO* System

WE have studied a serum containing an agglutinin, provisionally named 'anti-Ken' after the patient's name. This agglutinin was formed by a Polish patient, aged twenty-four, in response to pregnancies: the first ended in a stillborn macerated fœtus at term, the second was successfully interrupted by Cæsarean section during the thirty-seventh week. The patient was group A_2 *M CDe CDe Ken*- and her husband *B MN cDE cDE* (or *cDE cde*); we could not distinguish between these genotypes owing to the lack of anti-*d* and anti-*e* sera. The baby proved to be group *O MN CDe cDE Ken*+.

During the second pregnancy, as there were many possibilities of immunization, abnormal anti-*B*, *N*,*c*(*Hr′*), *d*(*Hr*) or *E*(*Rh″*) antibodies were searched thoroughly. The characters of the anti-*B* agglutinin remained normal: titre, 1 : 512, thermal optimum at 4° C., no exaltation by human serum or 30 per cent bovine albumin. At the thirty-second week an agglutinin was found active at 37° C. on certain *O* and *A* cells. It did not correspond to one of the *Rh* antigens mentioned above, nor to the *N* antigen.

Ten days after delivery a suitable amount of serum was obtained. It reacted strongly with the baby's cells and certain *A* and *O* bloods, giving a visual agglutination up to 1 : 4 and a final titre of 1 : 32 (in saline) at 37° C. Its activity was markedly increased when 30 per cent bovine albumin was used as diluent.

Testing with *A* and *O* cells of known *D* (*Rh*) type gave the following results:

Reaction with anti-*Ken*		+	—
248 unselected *A* and *O* bloods	*A* cells	46	45
	O cells	102	55
	D+ cells	132	83
	D− cells	16	17

There is at first sight an evident discrepancy in the distribution of *Ken*+ and *Ken*− cells among *A* and *O* groups, and, in a minor way, among *D*+ and *D*− cells. The latter does not appear to be significant whereas the former indicates a true difference between the *A* and *O* cell-groups. The χ^2 and p values are given in the following table. Owing to the small number of samples, the Yates adjustment was applied.

	χ^2	p
A-*O* distribution	4·396	0·036
D+ *D*− distribution	1·4814	0·224

The observed difference would appear by chance in only 1 in 30 trials for the *A*-*O* distribution and about 1 in 5 for the *D* distribution. Therefore the *Ken* antigen is found with a significantly higher frequency in the *O* group and is probably related to the *ABO* system. Its genetical transmission is being studied and will be described later.

We are indebted to Pr. Olbrechts and Mrs. Olbrechts-Tyteca for advice in the statistical work, to Drs. R. R. Race and A. E. Mourant for the sera used in genotype determinations, and to J. Snoeck for permission to publish the case.

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Error in Counting Reticulocytes

WHEN immature mammalian red cells, or reticulocytes, are stained with brilliant Cresyl Blue they may be differentiated from adult red cells and enumerated in a sample as a percentage. If these cells were scattered according to chance, reticulocyte counts would be expected to follow the binomial distribution. In a recent paper, however, Jacobsen, Plum and Rasch[1] have shown that, in their laboratory, reticulocytes appear to be more regularly arranged than this when present in a proportion greater than 10 per cent. They are therefore able to make counts on one sample with remarkably close agreement. Much of the important work on reticulocyte maturation carried out in their laboratory depends on the great accuracy with which this technique is used. It was therefore thought that an independent attempt to confirm this deviation from the binomial distribution would be of interest.

Replicate counts were made on a human case of pernicious anæmia with 13 per cent and on an anæmic rabbit with 20 per cent of reticulocytes. In all, 66,000 red cells were counted. In the human case the counts corresponded fairly well with the binomial distribution; but in the rabbit the counts were less regular.

These results differ markedly from those of Jacobsen, Plum and Rasch, who record increasing accuracy with the higher counts. The discrepancy may have been due to inferior skill both in making the preparations and in counting, for clearly a laboratory worker whose whole time is occupied in counting reticulocytes will attain an unusual ability. On the other hand, this technique gives great scope for unconscious bias. Reticulocytes cannot be distinguished from adult red cells as black from white. The maturation of a red cell is a gradual process, and reticulocytes merge imperceptibly into mature red cells. The difficulty is demonstrated in the photographs from which some of the counts made by Jacobsen, Plum and Rasch were taken. In the two examples published in their paper are six cells which we would consider mature reticulocytes, but only one of these is so classed by them.

In the simple enumeration of red cells, it is the highly skilled worker who can obtain closer agreement between replicate counts than the Poisson distribution will allow. Similarly, in counting reticulocytes, the highly skilled technician might be liable to bias in favour of excessive accuracy. Despite the care taken to avoid bias, it is therefore possible that the extreme accuracy of these authors may be due to the unconscious adjustment of counts by the inclusion or exclusion of the more mature reticulocytes. This possible source of bias could be eliminated if counts were made by a number of competent and independent hæmatologists from unmarked and unselected photographs made by Jacobsen, Plum and Rasch.

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[1] Jacobsen, E., Plum, C. M., and Rasch, G., *Acta Path. Microbiol. Scand.*, **24**, 554 (1947).

Innervation of the Adenohypophysis

THERE is strong evidence that the nervous system controls the pituitary gland and its secretions; but the exact nature of the control is undecided. General agreement exists about the importance of the nerve connexions for the normal functioning of the pars nervosa of the posterior lobe. The influence of the nerve supply on the adenohypophysis is, however, still under discussion and has been denied altogether. Experimental sections of the hypophyseal stalk and related hypothalamic structures have produced conflicting results; but no alternative way of nerve supply has been established, and the stalk is still considered the most probable link between the pituitary body and the central nervous system.

The morphological descriptions of the gland provide many references to the presence of nerve fibres in the glandular hypophysis; but few complete and detailed descriptions of the origin and endings of such fibres. Perhaps for this reason the evidence in favour of the abundant nerve supply of the gland has been usually under-estimated.

In a study of the rabbit's pituitary gland, using Cajal's method on frozen sections, I have been able to show the rich innervation of the glandular parts (intermedia, tuberalis and distalis). The nerve fibres come from the hypothalamic-hypophyseal tract. They appear mostly as isolated elements, passing directly from the stalk and from the pars nervosa (infundibular process) to the pars tuberalis and intermedia. They are particularly abundant at the junction of the pars tuberalis and pars distalis, a region named the 'zona tuberalis', which Harris[1] has recently studied. Individually or in small bundles, these fibres follow the general direction of the portal vessels and thus reach the pars distalis. Other fibres reach the pars distalis after crossing the pars intermedia, especially at its caudal end, where they are very numerous. In some cases the fibres leaving the hypothalamic-hypophyseal tract form a thick bundle which, before entering the zona tuberalis, runs along the stalk for a short distance quite separate from the main tract directed to the pars nervosa. This is particularly clear in new-born and very young animals.

The nerve fibres of the adenohypophysis seem to have an almost uniform type of ending as small clubs or knob-like formations applied to the cells. From the relative numbers of endings and cellular nuclei visible, there seems to be only one of these formations for each cell. Even when the fibres remain unstained, it is often possible to see clearly the nerve endings as black knobs or disks in almost equal numbers to the nuclei.

The accompanying reproduction shows some fibres in the pars distalis of the adult rabbit, and the small club-like endings are also visible in parts of the field. This type of nerve-ending was described and illustrated by Croll[2] also in the adenohypophysis of the rabbit, and by several authors in other species.

A full description of this work will be published elsewhere.

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May 24.

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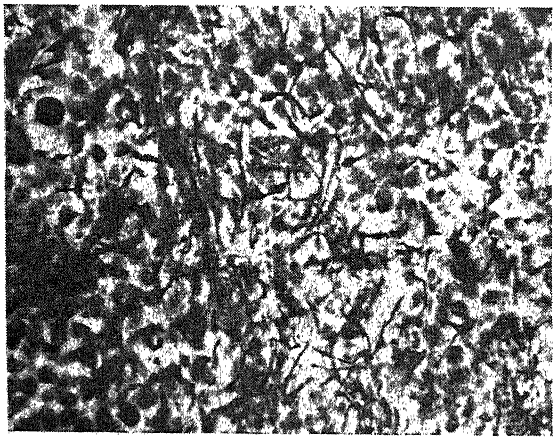
[1] Harris, G. W., *J. Anatomy*, **51**, 341 (1947).

[2] Croll, M., *J. Physiol.*, **66**, 316 (1928).



Occurrence of Thin Membranes in the Structure of Wool

WOOL keratin is considered to be completely soluble in sodium sulphide. 30 ml. of 0·3 *M* sodium sulphide was added to 1 gm. carefully purified wool, and this mixture was allowed to stand for about a month. After this time a light green solution was obtained, but the solution showed a slight opalescence. The particles causing this opalescence (estimated to be not more than 0·1 per cent of the wool) could be separated from the solution by centrifuging. After separating and washing with water, the solid matter was examined under the electron microscope. The specimen was mounted on collodion and observed directly. The solids proved to consist mainly of thin membranes, mostly rolled or folded, as is seen in Fig. 1. In order to determine the thickness of the membrane itself a collodion replica was made and gold-shadowed at a declination of 1 : 10. Fig. 2 shows how the thin membranes are rolled and the rolls flattened, probably by the surface tension during the drying. From the length of the shadows the thickness is calculated to be something between 50 and 100 A. Fig. 3 is a shadow-cast replica, where part of the wool membrane has stuck to the collodion. In part it shows both the membrane and the corresponding impression and is in that way interesting purely from the electron-micrograph point of view.

As these thin membranes are resistant to sodium sulphide, we think it justified to assume them to have a chemical composition different from the ordinary wool keratin.

It would be of great interest, of course, to know where the membranes are located in the wool fibre. It is also essential to know the chemical structure of the membranes and their behaviour towards chemical agents and enzymes. A chemical analysis is being carried out.

A sample of wool was strongly chlorinated and the excess chlorine afterwards removed by a solution of sodium bisulphite. The sample was then repeatedly treated by supersonics and the water dispersion from each treatment was examined under the electron-microscope. In the first suspension there were numerous fragments from membranes similar to those mentioned above. In the second and following suspensions the occurrence of the membranes was more and more rare, but the wool still had the fibre character and even partly a scale structure. This can be taken as an indication that the membranes are located in the surface layer of the wool. Further investigations are necessary before more definite conclusions can be drawn.

If it be a fact that these membranes are located at the surface or in the outer layers of the wool and do not dissolve in an alkaline and reducing agent like sodium sulphide, it may have an important bearing on surface phenomena such as the frictional properties of the fibres and the diffusion of dyes into the fibres.

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Action of Streptomycin on Plant Tumours

IN previous reports on the effect of streptomycin on plant tumours produced by *Phytomonas tumefaciens*, it was stated that this antibiotic substance would 'cure' a variety of plants of crown-gall[1], and that it killed tumour tissue in these galls without influencing normal cells[2]. To obtain more information about the action of this agent, experiments were performed using *in vitro* methods which made possible more exact control of dosage and closer observation of effects.

Cylinders of sterile carrot tissue 10 mm. diameter × 6 mm. high were placed on sucrose mineral agar. The upper surface of these fragments was covered with a suspension of fully virulent crown-gall organisms. About 15×10^8 viable organisms were applied to each fragment in this way. After 1, 2, 6 and 8 days, the fragments were transferred to sucrose mineral agar containing 50 γ per ml. streptomycin, and their upper surfaces were covered with 0·06 ml. of a solution containing 500 γ per ml. streptomycin. One group was left on streptomycin-free agar as a control.

After three weeks incubation in light at 25° C., the distribution of tumours in the variously treated groups was found to be as shown in the table :

Frequency of tumour formation in fragments of carrot tissue treated with streptomycin

Interval between inoculation and streptomycin treatment	Number of fragments showing tumours (out of 10)
1 day	1
2 days	3
6 days	10
8 days	10
Untreated control	10

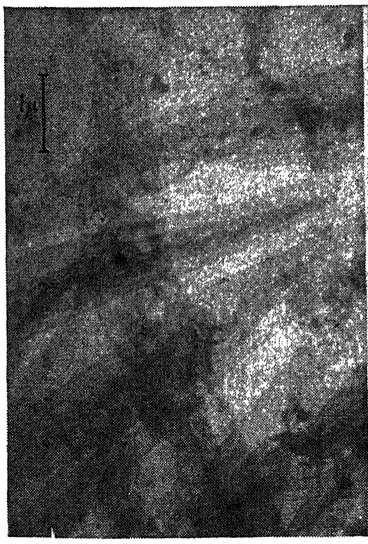


Fig. 1

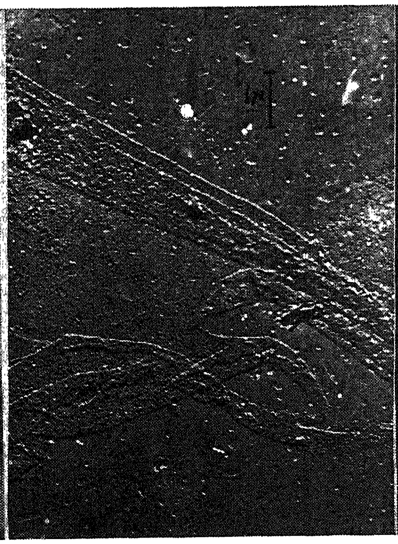


Fig. 2

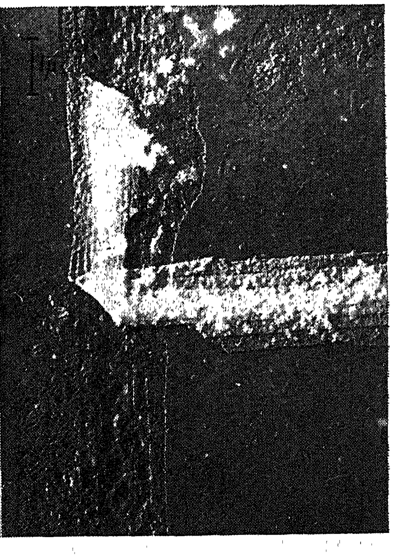
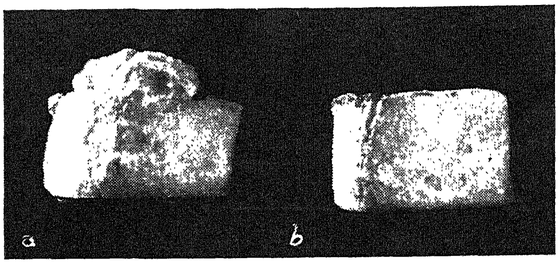


Fig. 3

Fig. 1. Electron micrograph of membranes from wool. Fig. 2. Collodion replica of the membranes on glass ; gold-shadowed Fig. 3. Collodion replica as Fig. 2 ; part of the membrane has stuck to the collodion



(*a*) Cylinder of carrot tissue treated with crown-gall bacteria and cultured for 3 weeks *in vitro*. A large green tumour has formed on the upper surface. (*b*) Cylinder of tissue treated as (*a*) but with 0·03 ml. of a solution of 500 γ per ml. streptomycin applied to the upper surface one day after inoculation. No trace of tumour formation was visible on this fragment

Where streptomycin was applied one or two days after inoculation, almost complete inhibition of tumour formation occurred. The tumours which did develop were very small. At six days, tumefaction had already started. Application of streptomycin at this time slightly reduced the growth of the tumours and changed their appearance, untreated tumours being green, treated ones white. The accompanying reproduction shows the difference in appearance between a fragment of carrot tissue on which the tumour developed and one on which it was inhibited by streptomycin.

When bacteria-free sunflower tumour tissue was cultured on sucrose agar containing 50 γ per ml. streptomycin, growth was only 65 per cent of that made by tissue on streptomycin-free agar. It was also found that 50 γ per ml. of streptomycin would completely inhibit the growth of roots on sunflower stem fragments treated with indole acetic acid, though it did not inhibit their initiation. It seems more probable that streptomycin is a general inhibitor of the growth of embryonic plant tissue than a specific inhibitor of tumour tissue. Its inhibiting effect on tumour formation is probably due to its action on the bacterial inciting agent.

This work was done in part on an American Cancer Society grant recommended by the National Research Council Committee on Growth.

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Antigenic Components of *Psittacosis* Virus

THERE is much evidence that viruses of the *Psittacosis-Lymphogranuloma* group are antigenically related. Some of the most active reagents for use in diagnosis by the complement-fixation reaction are virus suspensions which have been boiled[1]. It has also been found that treatment of egg-grown *Lymphogranuloma* by phenol and boiling, by urea or by extraction with ether yield products of enhanced activity which, however, will react with antibodies evoked by the heterologous as well as the homologous species[2],[3]. Many observations, recently reviewed by Cox[4], indicate the frequency of serological cross-reactions between various members of this group, and the production of specifically reacting antigens is clearly of importance.

Complement-fixation studies with hyper-immune guinea pig sera absorbed with unheated or boiled *Psittacosis* suspensions have led to the conclusion that this virus possesses at least two antigens, one destroyed by heat, the other resistant[5]. Evidence, not yet published, that specificity is a property of the labile antigen has also been obtained[6].

In other instances the serological activity of a specific antigen has been demonstrated, and the toxin neutralization experiments of Rake and Jones[7] suggest that this may be identified with the specific toxic factor which they describe. Mammalian sera may often be relatively deficient in specific antibody and there is evidence from infection neutralization[8] and complement-fixation tests[9] that avian sera are more potent in this respect. Virus agglutination methods may also be of value in detecting specific reactions[10].

In the course of an investigation into the antigenic properties of *Psittacosis* and related viruses, two types of antisera were prepared in the guinea pig: one designated 'complete' by the injection of *Psittacosis* in the fresh state, the other designated 'group' against the virus heated in a boiling water-bath. These suspensions were made from yolk-sac material, and the sera were tested by complement fixation against similar antigens from mouse spleen.

It was found that unheated antigens, rich in virus, gave variable results in that they might fail altogether to fix complement in the presence of either antiserum, but more often preparations of this sort gave good fixation with the 'complete' serum and very much less or no fixation with comparable dilutions of the 'group' serum. Regardless of its initial behaviour in the fresh state, heating the suspension consistently altered it, so that it reacted fully with both types of serum. The same effect was produced by treatment with papain or with dilute mineral acid.

As was expected, after absorption with the heated virus, the 'complete' serum retained reactivity only with the unheated preparation: similar treatment of the 'group' serum removed its fixing powers with the heated antigen as well as the small degree of reaction sometimes apparent with the unheated material. These findings confirm Bedson's previous observations on the complex antigenic nature of *Psittacosis*, and suggest that, in the living virus, the heat-stable factor is largely or, less commonly, entirely masked by one or more heat-sensitive components.

Attempts were made to improve the specificity of active, unheated suspensions with various reagents which might preserve and enhance the combining power of the labile antigen or suppress that of the group antigen. At the same time it was hoped that the effects of such treatment might yield further information about the composition of the virus particle.

The heat stability of one factor is very marked, and it was found to resist autoclaving for thirty minutes at 135° C. This property and its lack of sensitivity to a proteolytic enzyme suggest that it may be composed largely or entirely of carbohydrate. Conversely, the other reactive fraction might well be protein in nature.

The serological activity of heated *Psittacosis* was destroyed by 0·001 molar potassium periodate in thirty minutes at 37° C.; the minimal exposure required has yet to be determined. Unheated antigens treated in a similar manner with 0·002 molar solution reacted well with the 'complete' serum; to obtain this effect an increased concentration of virus was required in the test but, even at this strength, no reaction took place between the treated material and the 'group' serum. It would thus appear to have acquired a uniformly specific character.

It has been shown recently[11] that, in addition to its effect on carbohydrates, periodate may alter or inactivate biologically active proteins. Nevertheless, it seems likely that critical dilutions of this reagent may be helpful in the identification of some carbohydrate substrates. The inactivation of the heat-stable *Psittacosis* antigen by periodate is regarded as confirmatory evidence that the group component is, at any rate in part, carbohydrate.

A report giving full details of these and other observations bearing on the antigenic behaviour of *Psittacosis* is being prepared.

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Æcidia of Barley Rust in Britain

The æcidium on *Ornithogalum* species in Europe has an interesting nomenclatorial history. At first attributed to *Puccinia liliacearum* Duby, it was recognized by Bubak[1] as belonging to a separate heterœcious rust and named by him *Æcidium ornithogaleum*. Then, in 1914, Tranzschel[2] demonstrated in both directions its connexion with the common brown rust of barley, *Puccinia hordei* Otth. (syn. *P. anomala* Rostr.). This connexion has been confirmed by Mains and Jackson[3] in the United States of America; but, so far as we are aware, the æcidium has not hitherto been found in Britain. According to Sydow[4], it is known to occur in Germany, Austria and Hungary. D'Oliveira[5], who repeated Tranzschel's experiments and produced æcidia on *Ornithogalum* by inoculation from barley, was unable to find the æcidia in the field in England and concluded that barley rust survives the English winter in the uredo state on barley tillers and seedlings.

On March 14, 1948, one of us (N. Y. S.) collected spermogonia on a leaf of *Ornithogalum pyrenaicum* L. in Inwood Copse near Ham Spray, below Inkpen Beacon, on the borders of Berkshire and Wiltshire within the last-named county. These may have belonged to *P. hordei* or to *P. liliacearum*; but their occurrence stimulated our interest and led to our asking Mrs. F. Partridge, who lives at Ham Spray House and was present when the leaf was collected, to keep a watch for æcidia. Two æcidia were found on April 2, and on April 15 we received from her a consignment of thirty-two infected leaves. Twenty-seven of these bore spermogonia associated with teleutosori of *P. liliacearum,* five bore spermogonia and æcidia but no teleutospores. From the latter, inoculations were made at once to seedlings of common barley (unnamed hybrid seed); and on April 23, uredo pustules were visible on the inoculated leaves. They became erumpent on the following day. Subsequent careful search of the copse at Ham Spray has shown that *O. pyrenaicum* occurs there in two distinct patches. One adjoins the corner of an arable field which carried barley in 1947; the other lies between fields which carried wheat and oats respectively. The æcidia were found only in the former patch; *P. liliacearum* occurred in both, but mainly in the latter.

While it appears probable that persistence of the uredo stage is the chief method by which barley rust overwinters in Britain, the æcidia may be important in two ways. In the first place, *O. pyrenaicum* is locally abundant (with a discontinuous distribution) in certain parts of the south and west of England and may be responsible for initiating local outbreaks of brown rust. The plant occurs in north Somerset, west Gloucestershire, Wiltshire, Berkshire, Bedfordshire, Norfolk and Sussex. Secondly, presence of the æcidial stage affords opportunity for hybridization between existing physiological races of barley rust and for the production of new ones. D'Oliveira was able to distinguish five races of this rust in England. We suggest that it may be desirable to survey the known stations of *O. pyrenaicum* next April to ascertain to what extent æcidia are normally produced in Britain. Other species of *Ornithogalum,* especially *O. umbellatum* L., should also be examined for this purpose.

We are indebted to Dr. G. R. Bisby for help with the inoculations, and to Mrs. Partridge for her observations and for sending us material.

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Royal Botanic Gardens, Kew.
May 26.

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Velocity of Photons

Mr. H. Fletcher Moulton's paradox[1] is ingenious, but easily resolved. The energies of two photons emitted at the same place are *not* equal if each energy is measured in the co-ordinate system of the moving body at which it is absorbed. Each observer measures wave-length and velocity in his own co-ordinate system, and deduces the frequency and energy to correspond. The same remark elucidates the 'mystery' of the Doppler effect; but it must be remembered here that each photon does not show this effect. If one single photon could be received, it would presumably show no Doppler effect (or, indeed, wave-length at all—this is the classical deduction from photo-electric phenomena); the wave decides the probability of the photon being found at any given point, or the distribution of the photons if they are present in sufficient numbers.

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Dr. George Novello Copley, City Technical College, Liverpool, states that answers to Mr. Fletcher Moulton's questions are given in "A Textbook of Physics", by E. Grimsehl, vol. 5, "Physics of the Atom", p. 240 (Blackie, 1945), where the corpuscular interpretation of the Doppler effect is seen to be analogous to that of the Compton effect.

A NEW INTENSE SOURCE OF RADIO-FREQUENCY RADIATION IN THE CONSTELLATION OF CASSIOPEIA

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THE discovery by Hey, Parsons and Phillips[1,2] of a variable source of radio-frequency radiation in the constellation of Cygnus suggested that at least part of the galactic radiation was due to very intense discrete sources. Afterwards a detailed study of this region was made by Bolton and Stanley[3], using an interference system of greater resolving power; their results showed that the angular diameter of the source was smaller than the resolving power of their apparatus (8 minutes of arc), and the more precise determination of its position enabled them to show that the source does not coincide with any outstanding star. In a more recent note Bolton[4] describes the extension of this work and the discovery of other discrete sources.

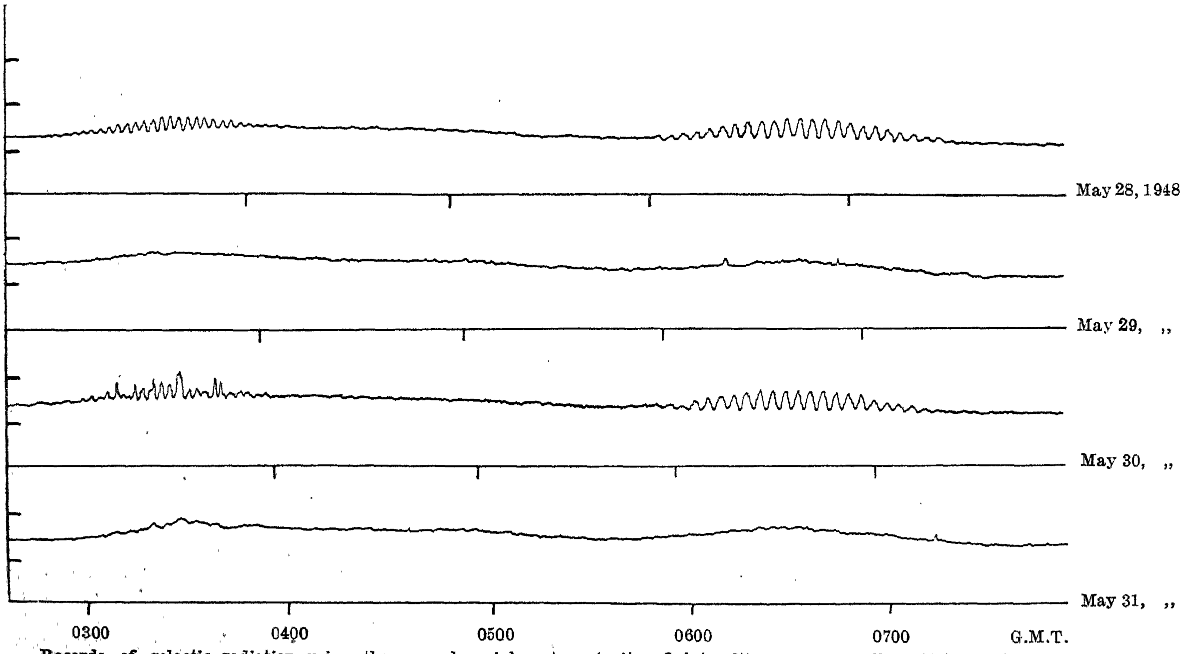
The similarity between the fluctuations observed from the source in Cygnus and from the disturbed sun has suggested to both teams that the mechanism for the emission of intense radiation from discrete galactic sources is likely to be the same as that of sunspot emission. The results obtained by many workers have shown that sunspot radiation is circularly polarized, and it is therefore of importance to measure the polarization of the radiation emitted by discrete galactic sources.

Recently we have carried out a series of experiments on a frequency of 80 Mc./s. to determine the polarization of the radiation from the source in Cygnus. During the course of this work we have found a new and more intense source situated in the constellation of Cassiopeia, as well as several minor sources having a smaller intensity than Cygnus.

In our experiments we have used the radio version of Michelson's stellar interferometer which we have previously described[5,6]. When making observations with a large resolving power, this type of interferometer has advantages over the method used by Bolton and Stanley, since no corrections are necessary for refraction in the troposphere or ionosphere. In order to identify the central maximum on the record we have limited the total width of the interference pattern by using two aerials of considerable directivity. By noting the times of the adjacent minima it is then possible to determine the Right Ascension of the source.

It can be shown that the periodicity of the interference pattern produced on the record by such a system depends on the declination (δ) of the source, and is given by $t_0 \sec \delta$, where t_0 represents the period of the central interference pattern for a source in the equatorial plane. It may therefore be seen that by measuring the period of the interference pattern the declination of the source may be found from the same record, without the need for an aerial system having a large resolving power in a north-south plane.

If the two halves of the aerial system are now mounted with mutually perpendicular planes of polarization, the system may be used to determine the polarization of the radiation from a galactic source. For a wave which is circularly polarized, the amplitude of the interference pattern produced will be the same as with the aerials parallel, but the phase of the pattern will be displaced by a quarter period. If the radiation is only partially polarized, the amplitude of the interference pattern will be reduced, and by comparing the amplitudes obtained with the two aerials parallel and perpendicular to one another, it is possible to determine the degree of polarization. (The full analysis of a complex wave is possible by this method, as has already been mentioned[6].)



Records of galactic radiation using the spaced aerial system (units of intensity are 5×10^{-22} watts/m.^{2}/(c./s.)). May 28, aerials parallel; (2) May 29, aerials mutually perpendicular; (3) May 30, aerials parallel; (4) May 31, aerials mutually perpendicular

We have used an aerial spacing of about 0·5 km. at a frequency of 80 Mc./s. An accuracy in Right Ascension of ± 10 sec. should be possible with this system for sources as intense as that in Cygnus, although our accuracy has been limited by the accuracy of time calibration to ± 20 sec. The determination of declination (δ) becomes inaccurate for small values of δ, but for δ greater than 30° an accuracy of $\pm 20'$ becomes possible.

Observations have been made between declinations of 0° and + 75°. In addition to the source in Cygnus, a more intense source was located in Cassiopeia, the radiation from which has been notable for showing considerably smaller fluctuations than that from the source in Cygnus.

Some typical records are shown in the accompanying figure (curves 1 and 3), in which the interference patterns produced by the sources in Cygnus (0335) and Cassiopeia (0640) can be seen.

The source in Cassiopeia has been found from these records to have a Right Ascension of 23 hr. 17 min. 50 sec. and a declination of 58° 0′ (1948 co-ordinates). The total intensity (twice the value obtained with aerials which accept only one component of polarization) has been found to be 23×10^{-23} watts/m.^{2}/(c./s.), with 'bursts' of radiation having an intensity of up to 6×10^{-23} watts/m.^{2}/(c./s.). The intensity of the source in Cygnus has been found to be 14×10^{-23} watts/m.^{2}/(c./s.) with 'bursts' of intensity up to 20×10^{-23} watts/m.^{2}/(c./s.). The aerial system has not yet been fully calibrated, but although the absolute values of intensity may be in error by as much as ± 30 per cent, the relative values are reliable.

A less intense but more variable source in Ursa Major (R.A. 12 hr. 20 min., declination 58°) has been found to give a maximum intensity of 5×10^{-23} watts/m.^{2}/(c./s.).

The angular diameters of all the sources which have so far been observed are less than the resolving power of the apparatus (about 6 minutes of arc for the two intense sources). The observation of 'bursts' of duration less than 20 sec. coming from the source in Cygnus has shown that the linear dimensions of the source of the variable component cannot greatly exceed the distance travelled by electromagnetic waves in 20 sec. If a source of this diameter (about 10^7 km.) is situated at the distance of the nearest fixed star, the observed intensity would correspond to radiation from a black-body source at a temperature greater than 10^{14} °K.

Observations made with the two halves of the aerial system mutually perpendicular have given records in which the amplitude of the interference pattern is less than 5 per cent of that with the aerials parallel. Some typical records are shown in curves 2 and 4. The results show that, within the limits of experimental error, the steady component of the radiation from both sources is randomly polarized. The determination of the polarization of the variable component of the radiation (see curve 4) is difficult, since the 'bursts' last for a time comparable with the period of the interference pattern, but a study of such records suggests that this component is also randomly polarized.

The detection of intense radiation from discrete galactic bodies has suggested that the radiation is due to processes similar to those occurring in sunspots. The observation that the radiation is not circularly polarized, however, suggests that the mechanism is somewhat different, and may not involve an appreciable magnetic field in the emitting region. The mechanism may possibly be more nearly analogous to the radiation from the undisturbed sun.

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VARIATION IN MORPHOLOGICAL AND BIOCHEMICAL CHARACTERISTICS OF ANAEROBIC BUTYRIC ACID BACTERIA

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IN attempts to identify the butyric acid bacilli not liquefying gelatin present in silage-fodder, cow fæces, milk and cheese, we generally found it very difficult or even impossible to determine the exact species of the organisms isolated. In most cases our freshly isolated pure cultures differed, in morphological and biochemical properties, from the species described in literature. Furthermore, one and the same strain, when repeatedly examined, frequently showed great variations with time; a certain strain, which behaved as a representative of the species *a* at one time, later showed the characteristics of the species *b*.

In order to get an idea of the variability of butyric acid bacteria, a great number of strains were isolated from various biotopes and investigated repeatedly. The 260 pure cultures thus examined were isolated from soil, green plants, silage-fodder, fæces of cow and sheep, spoiled process cheese, green cheese of Glaris, Emmentaler cheese, potato-, corn-, rye-, chestnut-mash, and polluted water. Direct isolations by means of smear-cultures on glucose – yeast extract – meat infusion – agar and glucose – yeast water – agar of various hydrogen-ion concentrations were made. In addition, enrichment media were employed, namely skim milk, glucose – skim milk, Winogradsky's solution, glucose – meat – peptone-broth, corn-broth, corn-liver-broth, and pea-broth.

So far the isolated strains have been examined for the following properties: (i) macroscopical appearance of the colonies on the agar media mentioned above; (ii) shape and size of cells and spores grown in various substrates; (iii) Gram-staining and formation of iodophilic substance; (iv) growth and liquefying power on gelatin medium; (v) changes brought about in litmus-skim milk with and without glucose; (vi) ability to ferment sodium lactate; (vii) formation of gas and acid from different carbon sources, namely glycerol, sorbitol, mannitol, xylose, arabinose, rhamnose, fructose, glucose, mannose, galactose, sucrose, maltose, lactose, raffinose, inulin, dextrin, starch, and salicin; (viii) changes brought about in corn-broth; (ix) fixation of atmospheric nitrogen. The results of the present investigation are summarized below.

In young cultures grown under strictly anaerobic conditions several types of colonies can be distinguished. There are colonies with entire margin and those with crenated margin. Frequently root- and hair-shaped projections are formed. Some colonies belong to the flat type, other colonies to the raised type. The colonies of young cultures are generally milky to dirty white, those of old cultures often yellowish or violet. Of special interest is the observation that the ability to form slimy colonies is of erratic nature. On the whole, the variability appearing within one and the same strain in characteristics of the colonies is striking.

Inconstancy also appears in the shape of cells and spores. Thus the different colonies of a strain may contain unswollen as well as more or less distinct *Clostridium-* or *Plectridium*-like rods. Even within one and the same colony, these more or less pronounced types of cells may be found in varying numbers. Young organisms always show motility. The spores are always oval and may have a central to subterminal location, the latter being predominant. In several strains free spores with a brush-like capsule as described by Winogradsky[1] for *Clostridium pasteurianum* were observed in the phase-contrast microscope. Spores possessing such appendages are, however, developed also by strains which have nothing to do with Winogradsky's organism. Special attention may be directed to the fact that the differences observed in appearance of colonies, cells and spores between various strains are not greater than those found, on repeated examination, within one and the same strain.

Young cells are throughout Gram-positive.

According to Svartz[2], the formation of iodophilic substance by butyric acid bacteria under certain conditions is to be considered a property of taxonomical value. The results of the present investigation do not support this view, the appearance of iodophilic substance in the cells being of the same irregularity as that observed in the properties described above. Two strains of *Clostridium butyricum iodophilum* Svartz kindly supplied by him could not be identified by means of the iodine reaction after having been mixed with our freshly isolated strains. Moreover, it was impossible to identify the two strains as a species on the basis of the properties dealt with in the present communication.

All strains show excellent growth but no liquefying power on gelatin medium. The same was the case with a strain of *Clostridium pasteurianum* Winogradsky kindly supplied by Prof. Kluyver, Delft (Holland).

All strains reduced litmus added to glucose – skim milk, generally within 24 hours. At the same time or a little later, a turbulent fermentation, that is, production of acid and gas, started in all cultures. In skim milk without addition of glucose, however, quite different results were obtained. The results of a typical test are seen in Table 1.

Table 1. Effects produced upon skim milk by freshly isolated strains of butyric acid bacilli

Number of strains	Effects
119	Turbulent gas evolution and strong acid production (coagulation)
10	Slight production of gas and acid (no coagulation)
12	Only slight production of acid
27	Slight production of gas without change of acidity
92	No change

Of particular interest is the fact that the activity shown by the butyric acid bacteria in skim milk is very inconstant, the results obtained with one and the same strain at different times, and even with one and the same cell suspension under identical conditions, varying considerably. Further, it is worth noting that there exists no obligate parallelism between the ability of the pure cultures to ferment lactose in milk and the ability to attack this carbohydrate in peptone – meat-broth. On this point our results do not agree with those obtained by van Beynum and Pette[3], who state that strains incapable of producing fermentation in milk do not attack lactose. The same authors state that the butyric acid bacilli may be divided into two distinct groups on the basis of their different ability to ferment lactose and lactate. Thus *Clostridium tyrobutyricum* van Beynum et Pette includes the strains capable of fermenting lactate but incapable of attacking lactose, whereas *Clostridium saccharobutyricum* Beijerinck is supposed to ferment lactose but not lactate. In view of the fact that lactate fermentation is of great importance in cheese- and silage-making, it seemed of interest to test our 260 strains for lactose- and lactate-fermenting power. The method employed was that introduced by van Beynum and Pette[3]. The results may be seen in Table 2.

Table 2. Fermentation of lactose and sodium lactate by butyric acid bacilli

Total number of strains tested	Number of strains fermenting				Total number of strains attacking lactate
	Lactate, not lactose	Lactate and lactose	Lactose, not lactate	Not lactose, not lactate	
260	48 (18·5%)	195 (75·0%)	15 (5·8%)	2 (0·8%)	243 (93·4%)

From the results given in Table 2 it is evident that most strains of butyric acid bacilli ferment lactate as well as lactose. A rather small number of the pure cultures examined attack only lactate, and a very small number only lactose, the former strains thus belonging to *Cl. tyrobutyricum* van Beynum et Pette, and the latter strains to *Cl. saccharobutyricum* Beijerinck. On further investigation, however, it was found that the specificity for lactate and lactose, respectively, is a highly variable property. Thus it could be demonstrated that strains, apparently attacking only lactate, in reality possess a latent power to dissimilate also lactose, and vice versa. Obviously there is no reason for maintaining the species *Cl. tyrobutyricum* van Beynum et Pette. This statement was further confirmed on examining two pure cultures of this organism and two pure cultures of *Cl. saccharobutyricum* Beijerinck kindly supplied by Prof. van Beynum, Hoorn (Holland). Of the former, one strain showed specificity for lactate. The other strain, however, was found to cause a vigorous fermentation of lactose as well as lactate. Both strains of *Cl. saccharobutyricum* attacked lactate.

As mentioned above, the ability of the isolated strains to ferment carbohydrates, higher alcohols, etc., has been studied, this ability often being supposed to be of great importance for the classification of butyric acid bacilli. The results of these tests are shown in Table 3.

It appears that, of the compounds tested, only fructose and glucose are fermented by all strains with simultaneous production of acid and gas. In the medium containing mannose, only one strain failed to induce fermentation. As to the ability to attack the other carbon sources examined, the strains showed great variation, some pure cultures attacking all or most of the compounds, other strains attacking only a few of them. Furthermore, it was found, on repeated investigation, that most of the strains, as regards fermenting power, showed an irregularity of

Table 3. Fermentation of various carbohydrates, alcohols and glucosides by butyric acid bacilli

Carbon source	Number of strains forming	
	Acid	Gas
Glycerol	121	120
Sorbitol	179	187
Mannitol	235	230
Xylose	212	195
Arabinose	221	186
Rhamnose	97	58
Fructose	260	260
Glucose	260	260
Mannose	259	259
Galactose	241	228
Sucrose	224	215
Maltose	229	202
Lactose	211	186
Raffinose	197	195
Inulin	179	173
Dextrin	185	205
Starch	166	172
Salicin	197	163

the same type and the same extent as that found for the other properties examined. For example, one and the same strain on repeated examination of one and the same carbon source may show no attack, attack with production of acid only, attack with evolution of gas only, and finally, attack with formation of both acid and gas.

We therefore agree with McCoy *et al.*[4], that it is impossible to use the fermenting power for the classification of butyric acid bacteria not liquefying gelatin.

According to McCoy *et al.*[4] the butyric acid bacilli not liquefying gelatin may be divided into two groups, called *Bacillus saccharobutyricus*-type and *Clostridium pasteurianum*-type, respectively. Strains belonging to the former group liquefy the starch gel of corn-broth, whereas those of the latter group do not. The results obtained in examining our 260 freshly isolated strains by means of the method described by the authors mentioned may be summarized as follows. Between absolutely inactive strains on one side, and strongly active strains on the other side, there are intermediate types attacking the gel only partially. No obligate parallelism could be demonstrated between starch dissimilation in corn-broth and the breakdown of this polysaccharide in peptone-meat-broth. Furthermore, the power of attacking starch showed the same variability as that observed in the other properties of the strains examined. Thus our results do not support a classification of the butyric acid bacteria not liquefying gelatin on the basis of the changes brought about in corn-broth.

On examination for nitrogen-fixing power in Winogradsky's solution, our pure cultures were found to vary considerably, qualitatively as well as quantitatively. A large number of strains which in their properties, for example, growth on gelatin medium, fermentation of carbohydrates, higher alcohols, etc., are not identical with Winogradsky's organism, induce a turbulent fermentation in the solution without nitrogen compounds.

From the results discussed above the conclusion may be drawn that it is impossible to base a reasonable classification of the butyric acid bacilli not liquefying gelatin on differences in the properties dealt with in the present investigation.

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RADIO COMMUNICATION AND THE IONOSPHERE

THE great strides made in the development of long-distance radio communication and broadcasting in the past ten years or so have involved the combined efforts of a large number of scientific workers, engineers and operators. These and older students of the subject have become aware of the fact that the transmission of radio waves to distances beyond the horizon and even right round the earth is only possible because of the existence of the ionosphere, which is that portion of the earth's atmosphere which becomes electrically conducting by ionization chiefly under the influence of ultra-violet radiation from the sun. But while this conducting region reflects radio waves and so returns them to the earth at a distant point, it does not behave as a simple metallic reflecting sheet in the same position at all times and seasons. It is rather in the nature of a series of partially conducting layers, one above the other, each varying in height and conductivity with time, and the lower ones sometimes shielding the upper ones from radio waves transmitted upwards from the earth's surface.

On account of the somewhat complicated nature of this subject, it was found necessary during the War to provide, in a suitable booklet, a background knowledge of the fundamental principles of the transmission of radio waves through the ionosphere for those interested in short-wave communication. Such a book was written by Mr. G. Millington of the Marconi Wireless Telegraph Company on behalf of the Inter-service Ionosphere Bureau and at the suggestion of the Admiralty. It was extensively used by Service Departments during the War, and it seemed to the Admiralty and the Department of Scientific and Industrial Research that the information it contained should be made more widely available for radio technical workers and students. It has therefore now been reprinted with only slight modification as "Radio Research Special Report No. 17—Fundamental Principles of Ionospheric Transmission" (published for the Department of Scientific and Industrial Research by H.M. Stationery Office, 1*s.* 6*d.* (U.S.A., 55 cents), by post 1*s.* 8*d.*).

This report describes the main properties of the ionosphere as a medium in which radio waves from a transmitting station are bent or reflected back to a distant receiving station. The effect of the angle at which the waves are projected from the earth toward the ionosphere is described, together with the influence of sunlight on the transmission, with its resulting possibilities for communication. The text is of a descriptive theoretical nature, and the use of mathematics has been kept to a minimum so that the treatment can be followed by as wide a circle as possible of those interested in this subject.

The book is primarily meant for those who can supplement the reading of it by attending a training course, and perhaps even more for those whose task it is in these days to conduct such courses, and who until now have been handicapped by the lack of any book of the scope of the present one. No reference is made to actual experimental results, such as the values of the heights and critical frequencies of the ionospheric layers, and the diurnal and seasonal variations of these values. The publication admirably fulfils, however, its intended purpose of providing a basis for appreciating and understanding the practical results that can be found elsewhere.

SOCIAL MEDICINE OF OLD AGE

THE Trustees of the Nuffield Foundation have published a report on the social medicine of old age prepared by Dr. J. H. Sheldon in a survey of a random sample of 477 old people*. His object was "to discover the medical and mental condition of old people living at home, and the stresses and strains to which both they and the younger people caring for them may be subject". The survey forms an appendix to the report entitled "Old Age", published by a Survey Committee under the chairmanship of Mr. Seebohm Rowntree. Wolverhampton was one of the towns covered by the Rowntree Report, and the same sample of people has provided the material for the new survey. The town, which has a population of 150,000, was selected because it was large enough to ensure a fair mixture of all income classes and sufficiently compact to enable the compiler to undertake the amount of visiting involved. Old age for the purposes of the survey has been taken to begin at sixty for women and sixty-five for men. The sample was obtained from the register of ration cards, every thirtieth name in the selected age group being included in the survey.

The earlier chapters of the report deal with what the author describes as the natural history of old age, and cover an assessment of the old person's health, ability to move about, the nature and extent of any illness, susceptibility to loneliness, extent of dependence on others for nursing care, shopping, housework and cooking, difficulties in climbing stairs, queueing, moving among traffic or in the dark and liability to fall. The analysis of the physical state of the subjects was based on a case-history supplied by the subjects themselves and by relatives, or in some cases by their general practitioners. No clinical examination of the subjects was possible, and for this reason the data permit no very accurate estimate of the nature of any existing disability. In particular, no precise evaluation can be made of the diseases and functional impairments which are specific to old age, or of the contributory factors involved in the phenomenon of senescence. The remainder of the report makes a valuable analysis of the ecology of old age; that is, its relation with the rest of the community, and the mutual stresses and strains set up.

One of the important points which emerges is the fundamental importance of the family in the social biology of old age. The problems of old people in the mass are domestic rather than institutional. The author favours the provision of temporary hostel accommodation which would enable those normally responsible for their care to obtain occasional relief. Another aspect which is referred to is the provision of old people's dwellings specially designed and carefully sited in building schemes of the future. The possibility of living in the environment to which they are accustomed, of having something to do, and of being still able to feel necessary to the world are of the greatest importance to old people, and may help to explain why the mental level of old people living in their homes appears to be so much better than that of those living in institutions. The sense of loneliness of old people and the disabilities which are inherent in old age are most successfully mitigated where children or relatives live in close proximity. This mode of life seems most satisfactory to both generations since it enables the old people to preserve their independence and the married children to live a separate life, while at the same time ensuring that help is at hand in time of need. There is, however, a darker side to the picture. Many old people, especially women, were found to be carrying a burden in the management of the home, and in some cases in the nursing of a sick husband, which was clearly beyond their capacity. In other cases the care of aged parents imposes a strain on the younger generation which is almost intolerable.

The findings of the report are not necessarily applicable to other towns, and no final conclusions can be drawn from the data which have been obtained. Nevertheless, the report is of value in directing attention to the kind of problems which besets old age and in indicating some of the ways in which these problems can be met. In a population such as that of Great Britain, where the age distribution is moving upwards, there is a clear need for further study of old age.

---

* The Social Medicine of Old Age: Report of an Inquiry in Wolverhampton. By Dr. J. H. Sheldon. (Survey Committee on the Problems of Ageing and the Care of Old People: Medical Sub-Committee on the Causes and Results of Ageing.) (Published for the Trustees of the Nuffield Foundation.) Pp. x+240. (London: Oxford University Press, 1948.) 5s. net.

RECENT RESEARCHES ON FOOD

THE first report of the Food Investigation Board since 1938 has only recently appeared*; but readers of scientific journals have been able to follow the work that has been done through the publication of separate papers on particular aspects of the work. The public in general has had a close acquaintance with the results of the work—if not of the work itself—in the war-time dehydrated foods and the special packagings that were adopted. Probably, however, few of those who complained about their dried egg and their household milk realized the amount of work that had gone into making it possible for us to have these foods at all. Here now is a chance for them to learn something of what was done on their behalf, for the successful application of the research findings was the result of close co-operation between the Board and the Ministry of Food.

The present report includes a summary of the work done during the years 1940–45 and a more detailed report for 1946, when the urgency of the war years had lessened and it was possible to resume "a more balanced and diversified programme of research which includes a fair proportion of longer range and more fundamental studies". This year also saw the reopening of the two 'market' laboratories, at Smithfield and at Covent Garden. The Torry Fisheries Research Station had been active throughout.

During the war years problems connected with the dehydration of foodstuffs and their subsequent use took first place—of necessity, since smallness of bulk was of particular importance in transport and storage. Now, however, there is opportunity once again to study such matters as the ripening and storage of fresh fruit and vegetables, the smoking and salting of fresh fish, freezing techniques and the composition of fresh carcases.

The work of the Food Investigation Board covers a multitude of problems arising from the processing, packaging, transport and storage of foodstuffs. Already we are a far cry from the primitive producer-consumer community whose diet is subject to very marked seasonal variations and shortages. All the work described in this report exemplifies man's increasing control over his environment and heralds a time when all foods will be available at all times and always in their most palatable and nutritional forms. (It will make life easy for the dietitians, but I wonder if it may not prove a little dull !)

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* Food Investigation, 1940–46. Department of Scientific and Industrial Research. Pp. 42. (London: H.M.S.O., 1948.)

However, that time is not yet, and meanwhile much of importance is being discovered. It is only to be expected, in view of the variety of problems that have to be tackled, that progress towards their solution is sometimes held up by lack of data on some fundamental issue. But a glance over the titles of the papers which have been published shows that even under war-time conditions these additional problems were tackled as they came, and in many cases a considerable advance was made in our understanding of the chemistry and physics of biological processes.

One of the most interesting points of advance—and the one which seems to have attracted most attention from other workers—was "the discovery of the reversible formation of starch from glucose-1-phosphate". A preliminary report on this work appeared in *Nature* of March 23, 1940, p. 451. No less important, however, are the contributions in other fields : the study of mucoproteins, of the chemical changes accompanying the development of rigor mortis, the general problem of the denaturation of proteins, the characterization of the components of connective tissue, the cause and cure of the lessening in biological value of milk powder stored with too high a moisture content.

None of this work is reported in full in this publication. For details the reader must refer to individual papers published in various scientific journals (references are given in full). This report is merely the outline picture ; but worthy of attention at that. It is a good example of science applied for the benefit of mankind and of the value of close co-operation between the scientific worker in the laboratory and the trader and administrator in the field. This co-operation was largely brought about by the urgent needs imposed by war-time conditions ; it is to be hoped that it may still be maintained now that the need is less obvious than it was.

M. W. GRANT

WORLD ECONOMIC SURVEY

THE broadsheet "World Economic Survey", issued as No. 283 by Political and Economic Planning, gives a very useful and concise summary of two large and valuable reports produced by the Department of Economic Affairs of the United Nations Organisation. This Department is carrying on the essential functions of the Economic, Financial and Transit Department of the League of Nations, which issued almost as its swan song the "World Economic Survey, 1942–44". The comprehensive picture which that report gave of the world economic situation on the eve of victory was supplemented by two other reports, "Commercial Policy in the Post-war World" and "The Cause and Control of Inflation", the former reviewing the problem of post-war trade policies and trade relationships and the latter monetary experience in Europe after the First World War, which especially for their review of the inter-war years are almost equally valuable in providing the background for the discussions of the Economic and Social Council and the Economic Commission for Europe, which it is the prime purpose of the two new reports to provide. These reports, "Economic Report : Salient Features of the World Economic Situation 1945–1947", with a subsequent supplement, and "A Survey of the Economic Situation and Prospects of Europe", are also intended to find their way into the universities and libraries, and the summary provided by P.E.P. will indicate to the industrialist the extent of the assistance they can give them as well as the economist and research worker.

The European survey provides the more precise and detailed body of information ; the most notable feature of the industrial progress of the European countries is the extent to which recovery was retarded in 1947. Agricultural recovery since 1945 has been less satisfactory than in the corresponding period after the First World War, and the volume of food imports into Europe was running in 1947 at about 10 per cent below the pre-war level. The scanty evidence available suggests that, in Europe as a whole, industrial output per man-hour was lower than before the War. The foreign trade of European countries expanded only moderately in 1947 after a rapid recovery in 1946, and an unsatisfactory feature was the sharp decline in intra-European exchanges of food, coal and other essential goods, while trade in luxury products increased. Little hope is entertained that imports of foodstuffs and raw materials can be reduced below pre-war levels, and restoration of equilibrium in Europe's external balance of payments will require a concentrated effort over a period of years. Success depends on the conquest of open or suppressed inflation, the restoration of trade within Europe to pre-war levels and a further expansion of production of the right kind of goods. The survey concludes that, given the continuation of the present high levels of employment, the prospects of attaining the existing production targets for the early 1950's are not unpromising, provided that intra-European trade and credit arrangements can be developed sufficiently to permit a more rational utilization of European resources, and that financial difficulties do not interrupt the flow of overseas supplies.

As regards the rest of the world, while the population is almost 10 per cent greater than ten years ago, food production is still well below pre-war levels, and even if the high hopes for harvests in 1948 are realized, serious deficiencies will remain. Reduction in livestock population is adversely affecting soil fertility and crop yields. Latin-American countries have all suffered from inflation, and the high prices of foodstuffs have lowered the standards of living of many of the inhabitants. Prospects for output and exports of primary commodities other than food in Asia and the Far East are still not very bright, and production, transport and administration will have to be improved greatly before Far Eastern foreign trade is likely to meet the needs of the situation. Areas of Africa which suffered heavily during the War have made marked recoveries, although agricultural output has tended to lag behind the increases in population. Apart from cereal shortages, Africa's most serious problem is the shortage of textiles. The level of industrial production in Australia and New Zealand has been high, but both countries are suffering from shortage of dollars. Both are anxious to continue industrialization, but to do this must promote a high level of immigration. The survey also throws a little light on the disruption of Soviet economy by the War, and the extent of its recovery.

FORTHCOMING EVENTS

Tuesday, September 21—Thursday, September 23

Institution of Civil Engineers (at Great George Street, London, S.W.1).—Conference on "Biology and Civil Engineering".

Institute of Petroleum (joint meeting with the Institute of Fuel, at the University, Edgbaston, Birmingham).—Conference on "Modern Applications of Liquid Fuels".

Tuesday, September 21—Friday, September 24

Institution of Naval Architects (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2).—London Autumn Meeting.

Thursday, September 23

Royal Institute of Chemistry (at the Technical Institute, Darnley Road, Gravesend), at 8 p.m.—Dr. T. W. Parker: "Estimation of Durability of Building Materials".

Thursday, September 23—Saturday, September 25

Faraday Society (at Ashorne Hill, near Leamington Spa).—General Discussion on "The Physical Chemistry of Process Metallurgy".

Friday, September 24

Department of Scientific and Industrial Research, Road Research Laboratory (in association with the Glasgow and District Association of the Institution of Civil Engineers, the Scottish Branches of the Institution of Municipal Engineers and the County Surveyors' Society, and the Scottish Accident Prevention Council, at the Royal Technical College, Glasgow), at 10 a.m.—Conference on "Road Research".

Biochemical Society (in the Department of Biochemistry, The University, Sheffield), at 11.30 a.m.—Scientific Papers.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Assistant Lecturers (2) in Engineering—The Registrar, The University, Manchester 13 (September 24).

Senior Technician in the Department of Pathology—The Secretary, Marischal College, Aberdeen (September 30).

Assistant to the Chief Officer of the Official Seed Testing Station for England and Wales, and a Crop Recorder—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge (September 30).

Chair of Pathology in the University of Adelaide—The Secretary, Universities Bureau of the British Empire, 32 Woburn Square, London, W.C.1 (September 30).

Principal Scientific Officer or Senior Scientific Officer (Mathematician) in the Department of Atomic Energy, Risley, Lancs.—The Ministry of Labour and National Service, Technical and Scientific Register, K Section, York House, Kingsway, London, W.C.2, quoting A.312/48A (September 30).

Assistant Lecturer in Biochemistry—The Registrar, King's College, Strand, London, W.C.2 (September 30).

Lecturer in Biochemistry in the Technical Education Branch of the Department of Public Instruction of New South Wales—The Agent-General for New South Wales, 56 Strand, London, W.C.2 (September 30).

Senior Lecturer in Physics in the Leeds College of Technology—The Director of Education, Education Department, Leeds 1 (October 2).

Senior Scientific Officers (with sound knowledge of emission spectroscopy or electronics, or radiation chemistry), and Senior Experimental Officers (well experienced in spectro-chemical or other modern methods of analysis), in the Chemical Inspectorate (Atomic Energy), Ministry of Supply, for analytical work involving modern physico-chemical methods—The Secretary, Civil Service Commission, Scientific Branch, 27 Grosvenor Square, London, S.W.1, quoting No. 2281 (October 7).

Senior Organic Chemist, Junior Research Chemists (3), and a Chemical Engineer, for the British West Indies Sugar Research Scheme—The Secretary, Imperial College of Tropical Agriculture, Grand Buildings, Trafalgar Square, London, W.C.2 (October 9).

Lecturer in Agricultural Bacteriology, and a Lecturer in Agricultural Zoology—The Secretary, Seale-Hayne Agricultural College, Newton Abbot, Devon (October 16).

Psychologist (non-medical)—The Establishment Officer, Prison Commission, Horseferry House, Dean Ryle Street, London, S.W.1 (October 16).

Chair of Zoology, the Chair of Botany, and a Lectureship in Physics, at Raffles College, Singapore (University of Malaya)—The Secretary, Inter-University Council for Higher Education in the Colonies, 8 Park Street, London, W.1 (October 30).

Senior Lecturer in Botany at the New England University College (University of Sydney), Armidale, N.S.W.—The Secretary, Universities Bureau of the British Empire, 32 Woburn Square, London, W.C.1 (October 31).

Readership in Chemistry at the Royal Cancer Hospital—The Academic Registrar, University of London, Senate House, London, W.C.1 (November 3).

Tutor in Social Case Work in the Department of Social Studies, University of Sydney—The Secretary, Universities Bureau of the British Empire, 32 Woburn Square, London, W.C.1 (November 30).

Chair of Natural History in the United College, St. Andrews—The Secretary, The University, St. Andrews (January 31).

Graduate (young, preferably with honours in chemistry) to join a small research team working on an industrial problem—The Registrar, Loughborough College, Loughborough.

Analyst to take charge of analytical laboratory—The Director, British Paper and Board Industry Research Association, St. Winifred's Laboratories, Welcomes Road, Kenley, Surrey.

Glassblower-Instrument Maker as technical research assistant in physical chemical laboratories, and a Bacteriological Technician for biological section of department of chemistry—The Steward, Chemistry Department, The University, Edgbaston, Birmingham 15.

Research Physicist or Engineer experienced in vacuum and high voltage work, to rebuild and operate a 400-kv. neutron generator and co-operate in biophysical research—The Secretary and House Governor, Mount Vernon Hospital and the Radium Institute, Northwood, Middx.

Geologists and Geophysicists in the Australian Bureau of Mineral Resources, Geology and Geophysics—The Australian Scientific Research Liaison Office, Africa House, Kingsway, London, W.C.2.

Research Chemist for biochemical work on fundamental problems related to the nervous system—The Director, Neuro-Psychiatric Research Centre, Whitchurch Hospital, Cardiff.

Nutritional Adviser for service with the Control Commission in Germany—The London Appointments Officer, 1–6 Tavistock Square, London, W.C.1, quoting F.B.76.

Lecturer in Agriculture—The Secretary, Seale-Hayne Agricultural College, Newton Abbot, Devon.

Associate Professor of Electrical Engineering—The Electrical Engineering Department, College of Engineering, University of Tennessee, Knoxville, 16, Tenn., U.S.A.

Lecturer or Assistant Lecturer in Botany, with special qualifications in Cytology—The Registrar, University College, Exeter.

Assistant Government Chemist in Nigeria, for duties in connexion with water supply investigation—The Director of Recruitment (Colonial Service), Sanctuary Buildings, Great Smith Street, London, S.W.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Contemporary Issues. (Quarterly.) Vol. 1, No. 1, Summer 1948. Pp. 80. (London: Contemporary Press, 1948.) 2*s.*; 8*s.* per annum. [157

R.G.S. Research Series. No. 1: Glaciological Research on the North Atlantic Coasts. By Prof. Hans W:son Ahlmann. Pp. iii+83. (London: Royal Geographical Society, and John Murray, 1948.) 7*s.* 6*d.* [157

United Nations Economic and Social Council: Economic and Employment Commission, Sub-Commission on Economic Development, Second Session. A Survey of the Technical Assistance available for Economic Development in the United Nations and the Specialized Agencies. (Prepared by the Secretariat.) Pp. 62. (London: United Nations Information Centre, 1948.) [157

Personal Recollections of the Nobel Laureation Festival of 1947. By Dr. R. E. G. Armattoe. Pp. 62. (Londonderry: Lomeshie Research Centre, 1948.) 8*s.* 6*d.* [157

B.I.O.S. Overall Report No. 3: The Timber Industry in Germany during the Period 1939–1945. Pp. 16. (London: H.M. Stationery Office, 1948.) 6*d.* net. [157

British Standard 904:1948. Dimensions of Instrument Jewels. Pp. 12. (London: British Standards Institution, 1948.) 2s. net. [157

Other Countries

List of Scientific Papers published in the Middle-East. Pp. 37. (Cairo: UNESCO Science Co-operation Office, 1948.) [286

Proceedings of the Zoological Society of Bengal. Vol. 1, No. 1, March 1948. Pp. 78. (Calcutta: Zoological Society of Bengal, 1948.) 5 rupees (10*s.*); 10 rupees (20*s.*) per Vol. [286

Annals of the New York Academy of Sciences. Vol. 50, Art. 2: The Chemotherapy of Filariasis. By L. L. Ashburn, F. C. Bartter, R. N. Bieter, F. J. Brady, L. M. Brancone, T. Brey, L. G. S. Brooker, H. W. Brown, E. Bueding, T. A. Burch, M. C. Clark, L. T. Coggeshall, D. B. Cowie, A. C. Cuckler, J. T. Culbertson, R. W. Cunningham, E. M. Cranston, J. J. Denton, S. Halliday, B. K. Harned, R. I. Hewitt, S. Kushner, J. T. Litchfield, Jr., W. L. McEwen, T. H. Maren, J. Oliver-Gonzalez, G. F. Otto, L. Peters, H. M. Rose, D. Santiago-Stevenson, H. W. Stewart, Y. SubbaRow, R. J. Turner, R. E. Vessey, W. S. Wallace, D. E. White, H. N. Wright and N. N. Yuda. Pp. 19–170. 2.50 dollars. Vol. 50, Art. 3: The Inhibition of Malarial Relapses by Toxoid of *Clostridium tetani*. By Eusebio Y. Garcia. Pp. 171–186. 75 cents. (New York: New York Academy of Sciences, 1948.) [296

Columbia-Presbyterian Medical Center. The Department of Medicine, 1921–1947. By Prof. Walter W. Palmer. Pp. ii + 30. (New York: Columbia-Presbyterian Medical Center, 1948.) [296

Catalogues

Books on Archaeology and Folklore, Arts and Crafts, Atlases and Maps, Bibliography, Costume, History, etc. (Catalogue No. 690.) Pp. 116. (London: Francis Edwards, Ltd., 1948.)

Air-spaced Articulated Co-Ax Cables for Radio Frequencies. (Publication No. 27.) Pp. 8. (London: Transradio, Ltd., 1948.)

A Selection of Interest Books on a Great Variety of Subjects. (No. 657.) Pp. 80. (London: Bernard Quaritch, Ltd., 1948.)

Gas Carburising with Prepared Town's Gas. (GC. 648.) Pp. 8. (Watford: Wild-Barfield Electric Furnaces, Ltd., 1948.)

Microscopical Preparations. (Catalogue 'A'.) Ninth edition. Section L: Collections of Slides in Botany, Zoology, General Biology, Cytology, Geology, etc. Pp. 40. (Manchester: Flatters and Garnett, Ltd., 1948.)

Meteorological and Scientific Instruments. (Catalogue No. 684.) Pp. 144. (London: C. F. Casella and Co., Ltd., 1948.)

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SCIENTIFIC AND TECHNICAL MAN-POWER IN BRITAIN

AMONG the specific issues of policy on which the Advisory Council on Scientific Policy was asked to make recommendations shortly after its first meeting in March 1947 were the arrangements for securing an adequate flow of scientific man-power to meet the needs both of Government and of industry. One section of the Advisory Council's first annual report deals with this problem in some detail, and may well be regarded as the most important section of the report. Since the Barlow Committee recommended in May 1946 that the output of scientific workers should be doubled so as to provide about five thousand every year, it has become apparent that attainment of this expansion within the immediate future is improbable, if not impracticable under present conditions. Furthermore, while on one hand the desirability of an expansion at the recommended rate has been challenged on the ground of the probability of the supply exceeding demand, on the other, fears have been expressed that too large a proportion of the available new scientific talent is being attracted to the Government services and that industry is not obtaining the recruits it requires.

In dealing with this task of keeping under review the probable demand for scientific man-power and the measures being taken to meet it, the Advisory Council on Scientific Policy investigated four primary questions: the number of scientific workers and technologists already available; whether the prospective supply of such men and women in the coming decade is likely to meet the expected demand, and, if not, what further steps should be taken to increase the output; and whether the present distribution of scientific man-power between defence and civil requirements is satisfactory. The last of these is clearly the most important question at the present time; but the answer we give to it must depend partly on the situation revealed by the examination of the first three questions. In regard to the first of these, the Advisory Council has discussed with the Ministry of Labour and National Service the possibility of arriving at a more accurate estimate of the existing number of qualified men of science and technologists than the rough calculation of 55,000 given by the Barlow Committee in 1946. The Ministry doubts whether the Central (Technical and Scientific) Register ever included more than about 85 per cent of the qualified scientific man-power in Great Britain, and the Advisory Council accordingly asked the Ministry to make a new survey with the view of ascertaining the numbers available at the present time.

A large number of replies have now been received to the questionnaire issued at the end of October 1947, and analysis of the results is expected to provide a very useful picture of the scientific man-power now available in Great Britain, with full details of the experience, qualifications and occupations of those covered. Further detailed reviews of the man-power position in particular fields of science are being carried out by the Ministry of Labour, and these reviews should also contribute to the more

Linlithgow Library

difficult question of estimating the prospective demand for scientific workers. Some of the recent inquiries, such as that carried out by the Industrial Research Committee of the Federation of British Industries, are admittedly inadequate, and the figure of 70,000 given by the Barlow Committee as the minimum demand for scientific men in the United Kingdom and in the Colonial Service has since been questioned, as well as the further estimate that the effect of raising the school-leaving age and the increasing need for qualified workers in Government service and industry would raise this figure to 90,000 by 1955.

The Barlow Committee estimated that unless the output of newly qualified scientific workers was raised from its pre-war level of about 2,500 per annum to 5,000 we could not expect more than 64,000 to be available by 1955. According to the Advisory Council, the latest figures which have been obtained from the universities indicate that this level has almost been reached and that the present output, if maintained, is therefore likely to meet the anticipated demand. Against this view, it has been stated that the Universities of Oxford and Cambridge will only be able to admit about one in twelve of the student applicants for the academic year beginning this autumn. The Vice-Chancellor of the University of Manchester, Sir John Stopford, has spoken of intolerable overcrowding there, and has told the University Court that the number of students, at present 5,460, might reach 6,000 in October, but after that would have to be kept appreciably below 5,000 until the building programme was under way.

The shortage of accommodation, which has existed since the end of the War, for entrants from school has been due essentially to the policy of giving preference to ex-Service men; but the procedure has naturally reacted harshly on members of the younger generation too young to be called up for several years service in the Armed Forces. The waiting list of ex-Service men with a claim for preference is not yet exhausted, and the majority of those already admitted have still to complete their courses. While this position obtains, even if the standard of acceptances from school reaches a much more satisfactory level than one in twelve, not only must many young aspirants to a university education be disappointed, but also, and equally important for the assumptions of the Barlow Report, the age structure of the intake of scientific workers will be affected adversely, and a longer time will be required before the level is stabilized at whatever figure, whether double or treble the pre-war, for example, may be deemed desirable.

This factor may, however, prove of minor importance compared with the others, such as building extensions and the assembling and training of the teaching and research staff to deal with the increased number of students, which are involved in implementing such a long-term policy as that recommended in the Barlow Report. A Committee appointed by Nuffield College, in its report "The Problem facing British Universities"*, is of the firm opinion that, until additional financial resources can be translated into buildings and equipment, and additional staff collected, the doubling of the university population contemplated by the Barlow Committee is not possible, and even the present increase of a half over pre-war figures is excessive. The provision which the universities can make for other needs—extra-mural teaching, intra-mural part-time teaching, advanced research, and the wide range of advisory work exacted by the Government from university staffs to-day—is stretched to the utmost.

The Nuffield Committee statement casts a very critical eye over the demands for university expansion, and although the Committee appears to be sceptical as to the justification for doubling or trebling the university population, it is unfair to suggest that it is opposed to expansion. It is concerned rather with the best way of dealing with an increased demand in the immediate future, and with the dangers which may result from allowing limited and sectional pressures to distort the balance and scale of university provision. It casts few doubts on the employability of more graduates in the national life; but it is concerned as to the maintenance of the sanctity of university life.

The significant factors with reference to the report of the Advisory Council on Scientific Policy which are stressed by the Nuffield Committee are that the present demands for university expansion represent many conflicting and unco-ordinated pressures. In the aggregate, the estimated requirements of the professions, Government departments and industry for graduates represent a 60 per cent increase on the 1938 numbers. What does not appear to have been considered is how all these demands can be met without fundamentally altering the character and purposes of university education, particularly during the next ten years, when the shortage of teaching staffs is the most critical factor.

It is with this danger in university expansion that the Nuffield statement is fundamentally concerned. It admits the need for expansion, although it reserves judgment as to the magnitude required. It calls for better planning of existing resources, and fo more thought about the aims and fruits of a universit education. It suggests that before deciding when an how to meet some of the sectional demands for ex pansion, we should first consider those demands i the light of the fundamental purpose of the universit We may need a re-statement of the principles tha should govern the life and work of a university if the demand for training for a career is not to be allowed to distort both the development and the functions of the universities.

The Nuffield statement puts these questions; but it does not attempt to indicate the answers. Its constructive suggestions are designed rather to ease the immediate pressure on the teaching staffs, and two of these are open to serious objection. The proposal to push back to the secondary schools a good deal of the instruction which is at present given in universities runs counter to a fairly general complaint that the schools are already giving much specialized instruction that should properly be giv n in the university. Certainly any increase in the influence of the university on the content of the school curriculum cannot be viewed without some concern that it may be detrimental to the interests of the many scholars who do not proceed to a university at all.

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* Nuffield College. The Problem facing British Universities. Pp. 131. (London: Oxford University Press, 1948.) 5s. net.

The second proposal is that universities in Britain should leave to the specialized institutions and technical colleges a good deal of the higher professional training that in the United States is undertaken by the universities. The Nuffield College Committee has in mind particularly the development of advanced schools for the study and teaching of engineering and other technological subjects and for the professional preparation of teachers, clergy and possibly others. The development in the United States as well as in Germany and some other European countries of such specialized institutions for advanced study and research is *prima facie* evidence that the suggestion deserves to be examined carefully. The Massachusetts and California Institutes of Technology and the *Handelshochschulen* of Berlin and Stockholm have assembled staffs and made contributions to research and teaching which few universities surpass. What chiefly distinguishes a university from them is a wider range of studies and a less specialized purpose.

Nevertheless, the separation of the study of engineering and other technological subjects from the universities and concentration in special schools, however closely located to the universities or friendly the association with them, has real dangers. In the first place, segregation of engineering and technological students in this way deprives them of the great benefit of a life shared with students in other fields, and may well encourage the narrowness of outlook so often condemned in the specialist. Conversely, not only have the students of engineering and other branches of technology a contribution to make to the corporate life of the university, sometimes out of proportion to their numbers, but also the teacher and investigator in these fields would, by such segregation, be deprived of the fertilizing and stimulating influence of close contact with colleagues working in such fields as mathematics, physics, chemistry and geology.

The first need, as the Nuffield College Committee rightly points out, is to define the specific function of the university and relate it to the functions of other institutions. In this matter of technical training, too, we need not only to be clear as to the justification for university facilities for any particular branch of professional or technological training, but also we need to recognize much more frankly that most occupations involve so restricted a range of theoretical or scientific knowledge that their technique can be acquired just as effectively and much more economically in the occupation than in a university. That is a consideration which bears closely on the correct distribution of scientific man-power, with which the Advisory Council on Scientific Policy is concerned.

A second conclusion reached by the Nuffield College Committee also touches that problem. Whatever the demands made on the universities, there is no possibility of meeting them unless the universities can draw from the schools a sufficient supply of undergraduates to be trained in accordance with those demands. Earlier in its report, the Committee endorses the view of the Barlow Report that in the present phase of expansion the universities must, so far as they are able, give the first priority to increasing the supply of university teachers and research workers. It then points out in this connexion that the fulfilment of even the sectional professional demands that are being pressed depends on the maintenance or improvement and extension of the general education given in secondary schools, and in particular that the universities must do all in their power to ensure that the schools can secure a regular supply of mathematicians, graduates in English and other languages, the classics and in science.

Complaints have been voiced that just as an excessive proportion of our scientific man-power is entering Government service rather than productive industry, so the staffing of schools with honours graduates in science of high ability is becoming increasingly difficult because of the more attractive and remunerative conditions in industry.

That is clearly a matter to which the Advisory Council cannot be altogether indifferent, although in its present report it merely considers the distribution of scientific man-power between defence and civil requirements. The question of higher technological training has been reserved for discussion in a separate report, and the survey of higher technical and other specialized institutions included in the Nuffield statement should prove a useful contribution to that discussion. The Advisory Council takes up the query raised by the Select Committee on Estimates as to the justification for the present distribution of Government research funds between civil research and defence research, and gives the estimate of about 13,700 scientific workers engaged in civil research as against 5,500 in defence research. The former figure includes 10,000 in industry, 2,500 in civil Departments of State and 1,200 in the research associations. The Advisory Council comments that much defence research and development is carried out by industry, while many scientific workers employed by the Government are concerned with subjects such as aeronautics and radar which have important civil applications, even when research and development are undertaken purely for defence purposes. The comparatively high Government expenditure on defence research as compared with civil research is due partly to the fact that the Government has to undertake directly or by contract all research or development for defence, whereas the main effort on the civil side comes from industry, and partly to the high cost of provision for development, design and prototype production in the defence field.

The Advisory Council has thus only touched the fringe of the general problem of scientific man-power, and in particular the question of distribution deserves rather fuller examination. The estimates of distribution in themselves merit analysis: on the figures quoted, qualified scientific workers employed by the research associations represented roughly some ten per cent of those engaged in Great Britain's total research effort, a proportion sufficiently high to warrant some examination of the question whether it yields a sufficient return in comparison with other forms of research effort. The whole question has a close bearing on the prospective supply, and it may well be found that the promised report on higher technological training will provide the occasion for a more adequate discussion of some of these issues, which require to be resolved before the form of university expansion over the next few decades is finally moulded.

CHRISTIAN HUYGENS

Christian Huygens and the Development of Science in the Seventeenth Century

By Dr. A. E. Bell. Pp. 220 + 7 plates. (London: Edward Arnold and Co., 1947.) 18*s*. net.

FOR many the most fascinating period in the history of science is the second half of the seventeenth century, the time when the foundations for the vast structures of to-day were laid with extraordinary sureness, solidity and speed. Newton, of course, was the supreme figure, a genius whose pre-eminence has been emphatically avowed by all men of science who have closely studied his achievement. The age was, however, rich in figures of outstanding gifts and accomplishment, and among them Christian Huygens holds a foremost place. He was, incidentally, one of the few to whom Newton paid generous tribute. Pemberton records: "But Sir Isaac Newton has several times particularly recommended to me Huygens's stile and manner. He thought him the most elegant of any mathematical writer of modern times, and the most just imitator of the antients . . .", the "antients" for whom Newton always expressed the greatest admiration. In the "Principia" he refers to "Sir Christopher Wren, Dr. Wallis and Mr. Huygens, the greatest Geometers of our time", and, acknowledging the gift of a copy of the "Horologium Oscillatorium", he writes ". . . Mr. Huygens's kind present, which I viewed with great satisfaction, finding it full of very subtle and useful speculations very worthy of the author. I am glad, that we are to expect another discourse of the Vis Centrifuga." Dr. A. E. Bell, whose book is before us, quotes the familiar "What Mr. Huygens has published since about centrifugal force I suppose he had before me", and adds "wrote Newton with some chagrin", which seems to be a quite unjustifiable comment.

That Newton had a just appreciation of the work of Huygens and fully understood it is significant, because Huygens signally failed to comprehend Newton's full achievement, although he realized Newton's greatness as a mathematician and as an experimenter. He criticized Newton's fundamental work on colour because it did not explain the ultimate nature of colour—"Besides, if it should be true that the rays of light, in their original state, were some red, others blue, etc., there would still remain the great difficulty of explaining, by mechanical principles, in what consists this diversity of colours". He did not understand Newton's "But to examine how Colors may be explained hypothetically is beyond my purpose". Huygens himself wrote little about colour, since the problem as he conceived it, to find a mechanical explanation, seemed to him intractable: "I do not think", he wrote, "that it would be easy to show what makes red or blue colours, nor am I much impressed in this matter by the Cartesian proofs. Certainly it has little or nothing to do with the geometrical method of reasoning."* He may not have been impressed by Descartes' particular views on colour, but nevertheless he himself was seeking a Cartesian type of 'explanation'. Again, he could not accept Newton's gravitating forces acting at a distance; but, although he rejected Descartes' particular way of explaining gravity by swarms of subtle particles, he himself published as late as 1690 a scheme which accounted for terrestrial gravity by a shell of particles round the earth behaving in a somewhat different way from that devised by Descartes. He never, apparently, really understood the essential nature of the advance made by Newton in his great hypothesis of universal gravitation.

To say this is not to disparage Huygens, whose fundamental achievements make a formidable list. His pendulum clock was the first accurate timepiece, and was based upon a thorough mathematical study of the compound pendulum and of oscillations in general; his discussion of centrifugal force constituted a fundamental advance in mechanics; his discovery of the rings of Saturn, a brilliant piece of observation, was conditioned by the great advance which he made in the construction of the telescope; his construction for the wave front by what is known as Huygens' principle is fundamental to physical optics and his treatment of double refraction showed the way for subsequent advances in crystal optics. This, which is only part of his record, is a sufficient performance, without crediting him with the wave theory of light, for which, in the ordinary sense, he can scarcely be held responsible. He is one of the really great figures in physics, and it is quite time that there was a book on him in English.

Dr. Bell's book is divided into two roughly equal parts, the first dealing with Huygens' life and the second specifically with his scientific work. This arrangement has the disadvantage that it leads to a certain amount of repetition, which even extends to a double use of the same phrases and quotations. The biography is simply set down, with a good discussion of the Cartesian influence, which, in spite of the fact that Huygens often disagreed with Descartes on mechanistic details, always remained strong. There is the usual denigration of Hooke: it is, of course, perfectly clear and just that Hooke was incapable of the beautiful mathematical development in which Huygens excelled; but it is not correct to say, as the author does, that Huygens showed as wide a range of activity. I can only suppose that he has forgotten Hooke's work in geology, physiology and architecture, as well as the extraordinary scope of his invention.

The matter of aerial, or tubeless, telescopes is not very clearly handled: the original suggestion came from Auzout, and, so far as I know, no successful use was ever made of them, as anybody who has tried to set up even a model can readily understand. Huygens presented to the Royal Society in 1691 an object glass of 121 ft. focal length, with eyepiece and subsidiary equipment for an aerial telescope. Somewhere about 1844 Admiral Smyth thought of trying to erect it; "the trouble, however, promised to be so much greater than the object appeared to justify that I laid the project aside". The impracticability of the device is not made clear in the book: a plate of the proposed instrument would have helped, and might have replaced, say, that of the Sebastian le Clerc engraving showing Louis XIV visiting the Académie des Sciences, of which the small half-tone reproduction gives little notion. Huygens' philosophical outlook receives some attention. There are many points, such as Huygens' visits to England, on which one would have liked a little more information; but naturally not much detail is possible in the hundred-odd pages devoted to general biography.

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* "Colores autem quid puniceos faciat aut ceruleos non facile ostendi posse existimo; neque hic multum Cartesianis demonstrationibus permoveor. Certe ad Geometricas rationes minime pertinet."

The chapter that introduces the treatment of Huygens' scientific work contains the remarkable statement: "The history of this mathematical treatment of phenomena is usually somewhat briefly dismissed, as if it all resulted from the insight of Galileo and Newton—and all the rest were fools". I wonder what writers Dr. Bell had in mind when he wrote this and the sentence ". . . it is simply not true that the dawn of the seventeenth century brought a universal belief in the operation of physical law and a discredit of magic and mystical agents". Did anybody ever suggest that it did? Huygens' work on impact is well summarized in one chapter. Very properly, a relatively considerable space is devoted to the "Horologium Oscillatorium", a book which contains, besides a detailed description of the pendulum clock, the fundamental work on oscillation in a cycloidal arc, on evolutes—which stresses the interest of the cycloid—and on the compound pendulum, the researches that established the centres of oscillation and of percussion. As Dr. Bell justly says, the fact that Huygens used geometrical methods instead of calculus for finding the moment of inertia makes this troublesome matter for the average reader of to-day. Incidentally, it has been suggested of Huygens, as it has of Newton, that he himself used analytical methods and afterwards threw the work into geometrical form, as being the gentlemanly way to do things. "Quoiqu'elle y soit exposée en grande partie suivant le style de l'ancienne Géométrie, on ne peut douter que l'analyse de *Descartes* ne soit le principal instrument dont il s'est servi", says Montucla. Dr. Bell also directs attention to Huygens' proposal to use the length of the seconds pendulum as a standard of length. It is not, of course, suitable, depending as it does on g, but it is the first indication of a search for a not completely arbitrary unit. The "Traité de la Lumière" is well handled in a chapter headed "The Wave Theory of Light", although the author properly points out that it is not really a wave theory in the modern sense but rather a pulse theory and that the conception of periodicity is nowhere introduced. The construction for the wave front and the wonderful treatment of double refraction are the fundamental advances made by Huygens. The work on geometrical optics that enabled Huygens to make good—and short, manageable—telescopes is briefly described, as are the Saturnian discoveries and the attempts to 'explain' the earth's gravitational field. A separate chapter is devoted to the posthumous publication, "Cosmotheoros", in which Huygens argued that the planets are probably inhabited. This little book achieved some popularity; it appeared in several languages and an edition of the English translation was published as late as 1757. It is, however, strange that Dr. Bell says nothing of "De Ratiociniis in Ludo Aleæ", a little work on probability of which Todhunter records, "This treatise of Huygens continued to form the best account of the subject until it was superseded by the more elaborate works of James Bernoulli, Montmort and De Moivre", nor of the work on coronæ and parhelia. They are surely worthy of mention, at least.

It is, of course, poor criticism to reproach an author for not having done what he has not attempted, and to many criticisms that might be made Dr. Bell would probably reply that he had not written a book for experienced students of the history of science, but for average readers. This, for example, would excuse the omission of any attempt at a bibliography of Huygens' books. It is, however, scarcely an excuse for the almost complete lack of references to sources or, still more, for the great carelessness shown as to names and dates. In the preface Thomas Power is cited when Henry Power is meant; the letter quoted on p. 45 was written by Sprat and not by Bishop Wren; on a single page the titles of two books by Kepler and one by Bartholinus are misspelt. These are but examples. Every author knows that a certain number of typographical errors are unavoidable, and there is no point in citing the number that this book contains. There are, however, too many bibliographical errors—Schott's "Mechanica Hydraulico Pneumatica" is not mainly about perpetual motion; at one place we are told "In 1674 appeared Hook's *Micrographia* with its astonishing mixture of skilful observation, pregnant intuition and mathematical insufficiency", although the correct date, 1665, is given elsewhere; the date cited for Kepler's "Epitome Astronomiæ Copernicæ" (1635) would make it a posthumous work, the true date of the first edition being round about 1620, and so on. These points are not mentioned in a carping spirit, but as indicating that the serious reader must be careful in taking facts from this book without verification. There is much, in fact, to indicate that Dr. Bell has not spent too much time with the books with which a writer on Huygens should be familiar. The "Short Bibliography" given at the end of the book "limited to comparatively modern publications" is also disturbing. It makes no mention of Bosscha's book on Huygens; the German history of physics that it quotes is one of the oldest and least informative; there are no references given for Huygens' mathematical work; if Delambre's history of astronomy is allowed in as a "comparatively modern" work, then Montucla's history of mathematics undoubtedly earns a place. Incidentally, the issue of Newton's "Principia" quoted as "English translation by F. Cajori 1934" was a re-issue of Motte's translation of 1729, although anyone might be pardoned for overlooking the fact. Complaints about the index are a failing of reviewers; but the index here is really deficient. I have noted well over fifty names that are mentioned in the text, many of them more than once, that are not indexed, and under the names indexed only about half the references that actually occur in the book are cited. Subjects are treated in the same perfunctory manner.

The reviewer would not be thought ungracious. He is grateful to Dr. Bell for having produced a book on Huygens and for having sent him for many hours back to the original sources. The book will be useful as giving a brief and readable account of the work of that great pioneer, and, no doubt, widely read. It does, however, require a thorough revision, however modest its aim may be, and it is to be hoped that, by the time that a second edition is called for, the author will have extended his researches.

E. N. da C. Andrade

SPOT TESTS

Qualitative Analysis by Spot Tests, Inorganic and Organic Applications

By Dr. Fritz Feigl. Third completely revised English edition, translated by Prof. Ralph E. Oesper. Pp. xvi + 574. (New York and Amsterdam: Elsevier Publishing Co., Inc.; London: Cleaver-Hume Press, Ltd., 1947.) 43*s.* net.

ONE of the most striking features of recent developments in qualitative and quantitative analysis has been the increasing use made of micro- or semimicro-methods. This is not, indeed, a modern branch of analysis; some of the old masters worked with very small quantities of materials. Wollaston's laboratory, we are told, consisted at one time of a tray containing watch-glasses, a blowpipe, and similar unimpressive objects, and when he had occasion to need a little calcium phosphate for a blowpipe test, he supplied it by scrapings of an ivory paper-knife. Berzelius created nearly all the chemistry of vanadium with a few grams of material. The so-called spot test, with which the present treatise deals, is also an old friend to most chemists; the use of test-papers and of an external indicator in titrations are examples of its early use.

There comes a time in the history of most branches of science, however, when some enthusiast sees the possibility of large extensions of a method, and by devoted and single-purposed work enlarges the field of some modest plot of knowledge until it becomes an imposing park, stocked with the most bewildering variety of forms. This task has been well performed for the spot test by Prof. Feigl, formerly of the University of Vienna and now in the Ministry of Agriculture Laboratory, Rio de Janeiro, who is well known to all chemists as the leading authority in this branch of analysis.

The book is a complete monograph. It deals with apparatus and technique, with methods, reagents, the exact details of procedure, and the results which may be expected. The field of application embraces metals, acid radicals, free elements, mixtures, organic compounds, and technical materials and minerals. In all cases, the most careful attention to detail is given, so that no user of the book who wishes to carry out any test described in it can have any doubt as to what he must do. Very full references to the literature are given (very few after 1939, and these mostly to the author's own papers), and there is a tabular summary and full indexes.

The reviewer looked up several examples of what might be expected to be found in the book, and was disappointed only once (salicylic acid). In his opinion, the book will find a welcome in all chemical laboratories. The use of spot tests in teaching is a matter on which divergent views will be held, and the reviewer does not think the present book is suitable for general use by students. A separate book, "Laboratory Manual of Spot Tests" (New York, 1943), has been written by Prof. Feigl for this purpose. A feature which struck the reviewer is the extending use which can be made of spot tests in organic analysis; according to the author, this branch of the subject dates only from 1928, and the extensive use of organic reagents in inorganic chemical analysis is also a newer development. Although the remark is not relevant to the present book, the reviewer would like to suggest that more attention should be given in teaching to the reduction in the quantities of materials used in organic preparations by students. There is little point in the teacher in the inorganic laboratory training a student to work with very small amounts of material and with small apparatus when the student, on entering on his training in organic chemistry, is encouraged to work with hundreds of grams and with large bolt-head flasks, as is too often the case because the laboratory manuals specify these quantities. Not only is unnecessary expense incurred, but also the student grows up with an increasing inability to work with the small amounts of material he will normally have available in research work. It has been the reviewer's experience that much of what the student has been taught in the course of quantitative inorganic analysis is undone in subsequent work in the organic chemistry laboratory, where the dirty bench and abundance of material are too often the rule. A short course of work on the lines of Prof. Feigl's manual would do much to restore a sense of proportion.

J. R. PARTINGTON

'HILLBILLY' FOLK-LORE

Ozark Superstitions

By Vance Randolph. Pp. ix + 367. (New York: Columbia University Press; London: Oxford University Press, 1947.) 21*s.* net.

THE Ozark country, or Ozarkland as it is sometimes called, covers some fifty or sixty thousand square miles and extends over the southern half of Missouri, the north-west of Arkansas and a few counties in Oklahoma. Although it is often considered to be a mountainous country, the hills are scarcely more than about two thousand feet, and the country consists of wooded land, gorges and ravines.

The name was first applied to this region by French-Canadian trappers, and the origin of the word is still in dispute, some maintaining that it is derived from Aux Arcs (*bois aux arcs*, wood for bows) and others thinking that it is connected with Azoic Arc. However that may be, the highland country was first settled early in the nineteenth century, and since then, largely owing to the bad soil and poor communications, the region has been to a certain extent isolated, and so has preserved many of the old folk beliefs and customs.

In the present volume Mr. Vance Randolph, who has already written a study of the Ozarks in which he deals with what he calls an "American survival of primitive society", has collected a number of the popular beliefs and practices which are still to be found by the field worker in this region. He attributes the survival of many of these beliefs to the fact that the people made little contact with the outside world since the pioneers came west from the Southern Appalachians. Although many Americans regard these 'hillbilly' people almost as foreigners, the fact is that many of them are of British stock and have been in America since colonial days.

In his discussion of Ozark folk-lore, Mr. Randolph has divided his material into subjects, and the book is really a collection of articles in which the beliefs and superstitious practices of the people are merely assembled without any analysis. In effect, the volume is little more than a catalogue in narrative form, and as such is certainly a useful compilation in view of the well-arranged index. Passing from beliefs on weather signs, the author goes on to discuss matters connected with crops, domestic management and water finders. These water witches or 'witch wigglers' are clearly ordinary water diviners or dowsers, although Mr. Randolph gives no indication that he is aware of these widespread beliefs. Moreover, it is a little difficult to understand why, when seeing one of these dowsers at work, the author should have "shivered" and felt as if the hair was rising on the back of his neck, a fact which he himself explains by maintaining that there was something "uncanny and obscene" about the divining rod.

Much of the folk-medicine and folk-beliefs concerning pregnancy and childbirth could be paralleled elsewhere, and it would be an interesting study to see how far these could be traced to early British sources. Although from what Mr. Randolph has said it would seem that Ozark superstitions are commonly held and of great variety, it would be a mistake to suppose that similar collections could not be made for other regions in which the population has not been cut off to the same extent as those living in Ozarkland. It is true that the superstitions of these less isolated communities would differ radically from those held in the Ozark highlands, but anyone who receives the lavishly produced catalogues of talismans, amulets and charms which circulate in the United States and who reads the advertisements in the newspapers of California and the Middle-West, will conclude that a study of these superstitions would be as entertaining and informative as those of the Ozark country here so assiduously collected by Mr. Randolph.

E. J. DINGWALL

RECLAMATION OF THE LAND

Land Reclamation

By P. J. O. Trist. Pp. 178 + 15 plates. (London: Faber and Faber, Ltd., 1948.) 15*s*. net.

THIS book gives an excellent account of problems facing the officers of the war agricultural executive committees in their task of increasing food production during the War. It was essential national policy that as much food as possible should be grown at home, and that so far as possible every acre of potentially good land should be cultivated. But several decades of agricultural depression had left their mark in thousands of acres of land being abandoned or being so badly farmed that in 1939 they made no worthwhile contribution to the national larder. Much of this land was potentially fertile; it was merely costly and difficult to keep in good heart and in many areas it had broken most of the farmers who were trying to get a living off it.

Mr. Trist confines himself to the problems facing the Essex Committee, of which he was first a district officer and then the cultivations officer, in deciding which under-farmed or derelict areas should be reclaimed, and the method of reclamation to be used. The soils involved were mainly heavy clays, either in derelict pasture or thorn scrub, and the work involved included clearing hedges, cleaning out ditches, seeing to the drainage system, and discovering the best methods of doing the critical cultivations before a crop was sown on most of the land. On some, however, the far more difficult problems of bush and scrub clearing had to be undertaken. All the multitude of problems arising from lack of experience, shortage of the proper tools and of suitable foremen for the large unskilled and often unwilling labour force that had to be drafted on to the land are dealt with clearly and at sufficient length for the intelligent general reader to appreciate the difficulties that had to be overcome in successfully carrying out these reclamations.

The book has also a great historical value, for it gives a very good account of the workings of many war organisations, such as the set-up of the county war committees, the difficulties of employing and limitations in using the various types of labour that had to be drafted on to the land, and many other of the day-to-day problems that arise when a great effort is needed to increase food production. Let us hope that the agricultural policy of Great Britain will continue to encourage the farming community to keep all their land at a high level of productivity, so that the lessons learnt during the War will not have to be slowly re-learnt if a future emergency arises.

E. W. RUSSELL

EGG-LAYING BATTERY MANAGEMENT

Eggs from Every Cage

Describing Laying Battery Management. By H. E. Swepstone. Pp. 83. (Worcester: Littlebury and Co., Ltd., n.d.) 7*s*. 6*d*. net.

MR. SWEPSTONE has written a book on laying batteries which should be of great value to the large number of beginners who are interested in this latest system of commercial egg production. The battery system is equally suitable for the domestic poultry-keeper with half-a-dozen birds, the commercial poultry-keeper and the general farmer, so that this useful little book should have a very wide reading public. The author has had twenty years experience of poultry-keeping, and after trying several methods he states that the best of all is the single hen laying battery. In fact, he would rather give up than attempt commercial egg production on any other lines. Surely this is ample testimony of the efficiency of this system.

This book is written by a practical man who has made a success of the battery system, and it provides all the information that the beginner is likely to require. There are excellent chapters and diagrams on the construction of houses and cages, the best way to start and the right management to get satisfactory results. The arguments in favour of starting with day-old pullets, or partly grown birds, are fully explored, and the man wishing to rear his own replacement stock will find the chapter on intensive rearing very helpful.

The method of accounting is well explained; but the figures of costs and returns would be very much more helpful to the beginner if they could have been converted to present-day values rather than pre-war. In his foreword, Mr. Swepstone asks the reader to substitute current prices for those given, and although this may present no difficulty to the experienced poultry-keeper familiar with the trend of prices, it is not so easy for the beginner, to whom the book will have the greatest appeal. Nevertheless, this handy little volume is well written in practical language and should be on the bookshelf of every poultry-keeper.

T. E. WHITTLE

SOME BIOLOGICAL ASPECTS OF COLONIAL DEVELOPMENT*

By SIR FRANK STOCKDALE, G.C.M.G., C.B.E.
Colonial Development Corporation

CONSIDERABLE interest is being taken by the people of Britain in Colonial development at the present time, and great importance is attached to the further development of Colonial territories in the interests of their inhabitants, the Commonwealth and the world.

In some quarters, extravagant views have been expressed as to the extent and the speed at which deficiencies of foodstuffs and raw materials in Europe can be met from the Colonies; but such views display ignorance of Colonial food requirements, social customs and habits, the poverty of their soils, the vagaries of rainfall, and the hazards from pests and diseases of crops, animals and men. Many of the Colonial peoples themselves are anxious to see the execution of projects which will develop the natural resources and provide them with a wider field of occupation and standards of living; but the road to achievement will only be traversed successfully if there is careful and sympathetic planning and persistent efforts to overcome difficulties.

Government Policy

Government policy is designed to improve and extend the public services and encourage economic progress so far as natural conditions and resources permit. Twenty years ago, a Colonial territory could only obtain financial assistance for active development through a guaranteed loan, but the Colonial Development Act of 1929 and the subsequent Colonial Development and Welfare Acts of 1940 and 1945 provided increasing State help for Colonial territories for post-war plans and centrally administered schemes of research, education and training, and these plans were designed to lead to better nutrition, water supplies, housing and communications, and in turn to better methods of production and higher standards of life.

To secure expanded economic development, the Overseas Resources Development Act was passed in 1948 establishing the Colonial Development Corporation with a capital limit of £110 million, and the Overseas Food Corporation, capital £55 million. The latter is charged with the execution of the East African Groundnut Scheme, and the former is to undertake projects to aid Colonial development generally, its activities covering agricultural, fishing, forestry and mining enterprises as well as industrial, processing and manufacturing undertakings. All projects must be financially sound, and it is the Corporation's intention to supplement, not supplant, private enterprise. It has already a considerable number of projects under consideration, and several have been investigated on the spot. It will start some projects this year, although shortages of basic materials must involve some delays.

Biological Factors

Biological factors have to be taken into account in Colonial development—particularly in Africa.

Population Issues. The increasing populations, their irregular distribution and the drift to the urban areas, emphasize the need for increased production of foodstuffs for local use; and greater occupational diversification is necessary in order to secure a more balanced economy.

Tsetse. Several species of tsetse flies occur on the African Continent and are responsible for the transmission of diseases to man, game, and domestic stock—accounting to some extent for the uneven distribution of populations and domestic animals. The area in which tsetse occurs is estimated to be seventy-five times the size of the United Kingdom. Tsetse flies are found in more than two-thirds of Tanganyika, and outbreaks of trypanosomiasis still occur. Whereas trypanosomiasis is under better control, thanks to increased knowledge and the production of better organic compounds with prophylactic and curative properties, the movement and resettlement of villages is still necessary. Tsetse research work of the past twenty years, including the study of the bionomics of the species and the ecological factors governing their control, has gradually built up a mass of information of the greatest value. It has been established that tsetse flies are susceptible to changes in environment brought about by clearing or thinning the bush, and successful reclamations of areas from tsetse have been achieved by bush clearing, provided that the subsequent tree-growths in the areas so dealt with have been kept in check. Progress, however, is slow, and large-scale clearing operations, such as those being undertaken by the East African Groundnut Scheme, may show the way to bring tsetse-infested country more rapidly into economic production; but no one can be satisfied about the present position. This is recognized by the authorities. Steps have recently been taken to place tsetse research under central direction, and international collaboration is also being secured on trypanosomiasis. Plans are also well advanced for insecticide dissemination by aircraft and helicopters, though the wholesale use of the new insecticides is not without danger, as many useful insects may be eliminated.

Livestock Diseases. In many parts of Africa these remain a factor which controls the development of animal industries and more satisfactory systems of agricultural husbandry. Rinderpest, the most serious of cattle diseases, still occurs in several territories; and although it had been hoped that in East Africa a check had been made on the disease, there have been recent outbreaks in Tanganyika, all the more serious because of the small number of veterinarians at work in the field.

Locusts. Crop losses of considerable magnitude have been experienced in the past in Africa from swarming locusts; but the extensive campaigns for the control of the desert locust in East Africa, and the successful control of the red locust in Tanganyika, have established the fact that locust plagues can be checked before they assume dangerous proportions provided the outbreak areas are supervised and timely action taken against incipient swarms. Spraying from aircraft can be applied effectively, and it has been clearly established that the results of the patient research work of the last twenty years, which are now being applied, are paying dividends.

Termites. Termites still remain unchecked and cause heavy unrecorded losses throughout the Colonial Empire. There is no British authority in the United Kingdom who has specialized in termites and their control, and it does seem high time to provide for a survey of the termite position in

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* Substance of a paper read before Section D (Zoology) of the British Association on September 10.

Colonial territories and for planned research. The establishment of a post at the British Museum (Natural History) for the specialized study of termites has been recommended; but a team for the scientific study of termites and the evolution of satisfactory control measures is warranted. A considerable amount of local knowledge is available in the Colonies about termite damage and the resistance of certain hard-wood timbers to attack. This knowledge requires to be collated and expanded by scientific research, and control measures need to be more generally adopted.

Pests and Diseases. Pests and diseases of plants and animals are also factors which have to be kept in mind. In addition to rinderpest, I need only mention certain virus and fungus diseases, such as the 'swollen shoot' of cacao in the Gold Coast, the 'sudden death' of cloves in Zanzibar and Pemba, the witches' broom disease of cacao in Trinidad, the Panama and leaf-spot disease of bananas, and then pass on to the pests of cotton.

The need for increased supplies of cotton from within the sterling area is great, especially at the present time. Owing to the research work of the Empire Cotton Growing Corporation and other specialists, many new types of cotton suitable to different areas and resistant to some pests and diseases have been evolved. Crop losses from jassids and other pests and certain virus diseases have been checked by breeding new resistant types. 'Stainers' are troublesome but not limiting; but the red boll worm (*Diparopsis castanea*) is the most limiting, and definitely controls expansion of cotton growing in large areas of Central, East and West Africa where the climatic regime consists of a single rainy season followed by a long severe dry period. Effective agronomic methods have been devised; but the use of insecticides may be necessary before cultivation can be expanded without undue risks in large sections of the continent.

Importance of Food Supplies

We in Britain are well aware of the shortages of food supplies; and in certain Colonial territories the people have not enough for satisfactory nutrition. Insufficiency of the B-vitamins, hungry periods between the seasons, serious shortages when the rains fail, definite protein starvation—particularly in the southern parts of the West African territories—all exist. Throughout the Colonial Empire there is a great need for wider variety in diet and a much greater consumption of protein foods if extra effort is to be expected in developmental projects. In Africa, it is probable that the growing populations will absorb the bulk of meat supplies available in the near future, and Colonial Governments must give the highest priority to the food needs of their people and to the stimulation of increased local production of crop and animal products.

Fishing. The fishery resources in the waters of Colonial territories have been neglected too long, and a wide field is open for development by the application of modern technology. The first stage is to establish a measure of the availability of fish in terms of the yield per unit of human and material effort expended in their capture and distribution, and then determine the level to which exploitation can safely be developed. Practical tests are an urgent need.

At a later stage it will be necessary to build up a body of basic scientific knowledge of the fisheries so that the level to which exploitation can safely be developed can be determined.

An ambitious programme of research has been planned, including the development of freshwater fisheries and the establishment of fish farming in several areas. There are obviously vast possibilities of increasing fish supplies by fish farming, and a Government training and research centre is to be established in Malaya.

The whaling industry has been developed largely as the result of the whale fishery investigations of the "Discovery" Committee of the Colonial Office. This industry is an example of complete dependence on fundamental oceanography and marine biology. Through this work the vast biological productivity of the southern oceans is made available for human needs, with a reasonable assurance of a maximum sustained production.

Mechanical Aids to Colonial Agriculture

Colonial agriculture is dependent largely upon peasant producers—many of whom grow their crops on small areas for subsistence purposes. In the main, their husbandry methods and animal industries can be greatly improved, though with the existing tools and the methods in vogue increased productivity is difficult to achieve. The requirements at present are to secure better organisation of farming operations and to test the value of fertilizers and mechanical aids. The effects of the introduction of mechanical implements on the farming economy and the social organisation of the people will require careful study and investigation, as their introduction will necessitate farming units of a larger size, whether cultivated individually or communally. The possibilities of increased soil erosion and dangers from pests and diseases must not be overlooked. Useful lessons will doubtless be learned from the East African Groundnut Scheme.

The East African Groundnut Scheme

There is no doubt that the world shortage of edible oils made it essential that this project should be undertaken. It will have an important influence on the agriculture of Tanganyika and on Colonial development generally. I have recently had an opportunity of paying a short visit to the Kongwa area, where the speed at which equipment could be assembled for bush clearing, cultivation and harvesting has been much slower than had been anticipated. Much of the equipment had to be reconditioned or modified and some new implements evolved; but many of the technical difficulties on the mechanical side have now been overcome, and those responsible are to be congratulated on their achievements. Unforeseen difficulties had to be expected and allowed for—this is always the case in pioneering ventures—but the groundnuts and other crops this year have been free from any serious attacks from pests in the Kongwa area, except for damage to the sorghums in the experimental area. There has been some loss of certain groundnut varieties from wild pig; but no occurrence of the virus disease, rosette, which is capable of causing serious losses, has, so far, been detected. It is very necessary, however, that the research work undertaken by the scheme should be well in advance of requirements, so that outbreaks of rosette and of other pests and diseases can be met when they arise.

An extensive programme of field trials to investigate crop rotations, fertilizer needs, cultivation methods and groundnut varieties, as well as a large series of observation plots with a wide range of crops have been put into effect this year, and valuable lessons have already been learnt. This work has been given the highest priority, and steps have recently been taken to increase the scientific staff. It is to be hoped that arrangements will also be made for the testing of a wide range of groundnut varieties for resistance and immunity to rosette disease in an area of the territory where the disease occurs in some abundance, as in my view such work can only be regarded as a necessary insurance.

Conclusion

A considerable increase of basic knowledge is being built up as the result of Colonial research work; but there are still gaps in our knowledge. The application of the results of research work also leaves much to be desired. The strengthening of the staff of the British Museum (Natural History) appears to be desirable in the interests of Colonial biological research. Termites, in particular, require further study. It is also necessary that early steps be taken to enable Kew to produce a Flora of East Africa. Such a Flora is not at present available, and its production is essential for further ecological work in the East African territories and for the use of biologists working in these territories.

HIGHER EDUCATION IN THE COLONIES

It was a graceful gesture by the Sixth Congress of the Universities of the British Commonwealth to devote its concluding session on July 23 at Oxford to a discussion of higher education in the Colonies, and thus to recognize and welcome the youngest members of the academic family.

The discussion, under the chairmanship of the vice-chancellor of the University of London, Prof. Hughes Parry, was opened by Sir Alexander Carr-Saunders with a sketch of the general plans for developing university institutions in the British Colonies and in the Sudan. In addition to the two existing Universities of Malta and Hong Kong, there will soon be, in Malaya, a third university if the proposals of the recent commission are adopted for the fusion of the King Edward VII College of Medicine and Raffles College. Five new university colleges are being established, two on the basis of existing institutions, Gordon Memorial College, Khartoum, and Makerere College, Kampala, serving the East African territories, and three as new foundations, University College, Ibadan in Nigeria, the University College of the Gold Coast, and the University College of the West Indies in Jamaica. These five university colleges are autonomous corporations, governed by councils the composition of which ensures that they are broadly representative of the interests concerned in their territories, including Government, and include an effective proportion of academic staff representatives. Control of all academic matters is vested in academic boards, composed wholly of members of the staff. The students at these colleges will sit for the degree examinations of the University of London, with which the colleges will be "in special relationship". By this arrangement, the University of London, while retaining complete control over the award and standards of its own degrees, is prepared to devise, in consultation with the colleges, syllabuses appropriate to the needs and opportunities of the territories and to associate the local staffs in the setting of papers and marking of scripts in the examinations. After gaining experience in constructing syllabuses for special degrees, in conducting local examinations and in establishing firm standards, the colleges will in due course seek degree-granting powers and become independent universities.

A sum of six million pounds from central funds administered on the advice of the Colonial University Grants Committee is available as a contribution towards the capital needs of this programme (excluding the developments in the Sudan). Grants for recurrent expenditure will have to come chiefly from the local governments, and arrangements are being made for such assistance to be given as block grants for quinquennial periods to ensure a proper degree of independence for the colleges. Academic assistance, technical advice, library services and co-operation in a variety of ways from the home universities is provided through the Inter-University Council for Higher Education in the Colonies. The critical need in the next phase of carrying through these plans for a new university and five new university colleges is for properly qualified staff. The conditions of service, the salaries, the academic freedom, the research opportunities, the responsibility of the work make service in these university institutions attractive, and every effort is being made by Inter-University Council visits and other means to overcome some of the disadvantages that formerly existed in Colonial work such as the relative isolation. Sir Alexander Carr-Saunders concluded by appealing to the Dominion universities to interest members of their staffs in serving in the Colonial institutions, either in permanent appointments or on temporary secondment.

In the discussion which followed the opening address, Mr. Lewis Wilcher, principal of Gordon Memorial College, and Dr. Kenneth Mellanby, principal of University College, Ibadan, paid tribute to the assistance given to their colleges by the Inter-University Council and by the University of London. Mr. Wilcher reported that Gordon College hoped to obtain independent university status within ten years, and emphasized the value of the services which higher education had to render to the Sudanese in their rapid progress towards self-government. Dr. Mellanby stated that University College, Ibadan, was beginning in temporary buildings near the permanent site of five square miles which the Nigerian Government had presented, in addition to making a contribution of £500,000 towards the recurrent expenditure of the College in the first quinquennium, and an initial grant of £250,000 to an endowment fund. The College would have two hundred students in residence for the session 1948–49, and expected an annual intake of a hundred. Local groups were springing up throughout Nigeria to collect funds to be placed at the disposal of the College for awarding scholarships.

Mr. H. R. Raikes, vice-chancellor of the University of the Witwatersrand, hoped that the Colonial medical schools would ensure that the students' training made full use of the special opportunities provided by the local clinical material and experience, and pleaded that dentistry should be treated as of equal importance and urgency as medicine; he suggested that external examiners going to the Witwatersrand from the

United Kingdom should be encouraged to visit the Colonial medical schools *en route*. Dr. E. G. Malherbe, principal, Natal University College, stressed the dangers of mass literacy campaigns and elementary education in Africa in exposing the peoples to irresponsible propaganda and to some of the less-desirable features of Western civilization if they were not accompanied by the parallel process of providing the enlightened leadership and critical interpretation which the Colonial university institutions would give.

Dr. J. W. Davidson (Wellington University College, New Zealand) directed attention to the danger of importing into the Colonies European standards and conceptions of university education insufficiently adapted to the conditions and interests of the local communities, and thus losing deeply rooted popular support for the new colleges. Prof. A. R. Humphreys, of Leicester, suggested that a practical step to remove one of the deterrents to recruitment, namely, fear that it would be difficult to return to home university posts, would be the prompt and systematic notification of appropriate vacancies to staffs serving overseas.

Principal H. J. Page described the activities of the Imperial College of Tropical Agriculture, Trinidad, the primary task of which is postgraduate training in tropical agriculture of students entering the Colonial agricultural services; a secondary function has been training students, chiefly from the West Indies, for a local diploma. The College hopes soon to co-operate with the University College of the West Indies in providing teaching for the London degree in agriculture. Mr. Bernard Williams, dean of the Medical School, described the plans for opening the Faculty of Medicine of the University College of the West Indies in October, the special problems created by the scattered territories of the West Indian Colonies, the assistance which the College had received not only from the Inter-University Council and University of London, but also from McGill University, and the methods by which it was hoped to overcome the technical difficulties in the secondment of clinical teachers.

Prof. W. E. Dyer, principal of Raffles College, Singapore, stressed the importance of the secondment of university teachers to the Colonial colleges as a means of reducing the isolation and fear of loss of academic status of the local staffs. Prof. F. L. Warren, Natal University College, considered that one reason why a greater number of French than British scholars had remained in service in Egypt was that staff seconded there from the Sorbonne or University of Paris were granted in two years the seniority which would accrue from three years service in France; he suggested that the overseas institutions would attract visiting specialists if they made it known that they could offer working facilities and cheap residential accommodation, such as were provided for visiting astronomers and marine biologists in Egypt.

Prof. Lillian Penson, of the University of London, in concluding the discussion, stated that every effort was made, through full consultation with local opinion and by other means, to harness the sympathy and support of the peoples to their university colleges, and that, far from any forcing of standards by the University of London or the Inter-University Council on the local communities, the demand for the highest standards and nothing less came from the peoples themselves. Secondment on temporary service to the Colonial colleges gave an opportunity of attractive work; from her knowledge of the quality of Sudanese students, she felt confident that staff need have no fear of lowering standards; and the risk of isolation or of being lost sight of was greatly diminished by the work of the Inter-University Council, particularly by its regular visits.

ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH, PRINCETON

By Dr. J. A. V. BUTLER

Many scientific workers will have heard, with regret and possibly incredulity, of the impending closing of the Princeton Laboratories of the Rockefeller Institute for Medical Research. The decision to close these Laboratories and to concentrate the work of the Institute in New York was reached in the spring of 1947. The Laboratories are to be closed by 1951; but if an acceptable offer for the site and plant is received before then it will be accepted. Any members of the staff who wish to do so may continue their work in the New York Laboratories.

It would be impertinent to question the reasons which have led to this decision; but friends of the Laboratory, as well as many who have been privileged to receive its hospitality, will be distressed that it should be necessary. The founding of the Princeton Laboratories was a logical consequence of the policy of the Rockefeller Trustees to provide facilities for the study of disease in all its manifestations, in animals and plants as well as in human beings. This policy was magnificently justified by the results achieved, and to an onlooker it seems a grievous and deplorable loss to science that it should be found necessary to reverse it.

The Rockefeller Institute began its work in a temporary building under Dr. Simon Flexner in 1904. The present New York buildings on a site overlooking the East River were begun in 1906 and have provided both a hospital for the study of special diseases and a wide range of laboratories covering all branches of biochemistry and physiology.

The policy of the Trustees to study disease in all its forms led to the establishment in 1914 of the Department of Animal Pathology with laboratories on a country site near Princeton, under Dr. Theobald Smith, who was succeeded in 1930 by Dr. Carl Ten Broeck. In 1931 the plan to provide, in one organisation, for the study of disease as it occurs in all the main orders of living things was completed by the addition to the Princeton establishment of a Laboratory of Plant Pathology. The Princeton Laboratories also housed a Laboratory of General Physiology, under Dr. J. H. Northrop, which has devoted itself to investigations of the nature of enzymes and other biologically active proteins of animal origin.

The world-wide reputation of the Princeton Laboratories was based in part on the isolation of a large number of crystalline enzymes and their precursors in Dr. Northrop's laboratory, and on Dr. W. M. Stanley's isolation of the tobacco mosaic virus and succeeding studies in the Department of Plant Pathology. Although the first isolation of a crystalline enzyme was achieved by Sumner in 1926, it is not too much to say that the work of Northrop and his colleagues, leading to the purification and crystallization of a long series of enzymes and related substances, has done more than that of any other group to open up the chemistry of enzymes; while, as is well known, Dr. Stanley's work decisively initiated the modern studies of virus particles. Numerous discoveries in animal pathology were also made within the laboratories, for example, Shope's rabbit papilloma, and many others, which the writer regrets he is unable to describe adequately.

It is most regrettable that the staff and equipment by which such results have been achieved should be dispersed. The main reason for the decision is apparently the contraction of the funds available and also a desire to concentrate the available resources on the Hospital and its auxiliary laboratories. It is understood that attempts made to enlist sufficient financial assistance to make possible the continuation of the Laboratories as a scientific unit were unsuccessful. Many of the younger members of the staff and some senior ones have already accepted posts elsewhere.

The result is the dispersion of a most valuable scientific establishment, which made a contribution to biological and medical research of unique importance. Situated a few miles from the university town of Princeton and within easy reach of New York, it was an ideal site for scientific work. The many British workers who enjoyed its hospitality will remember the efficient organisation of its well-equipped Laboratories and the friendly and agreeable atmosphere of its club-house, and will regret its passing acutely.

RADIATIONS AND HEALTH

A DOSE of radiation above the accepted tolerance limit of 0·5–1 roentgen per week presents hazards to the individual, notably those of sterility and cancer, and to his progeny—in the form of recessive mutations. The importance of the former effects has been recognized since the beginning of the century mainly as a result of the all too obvious injury to many of the early workers with radium and X-rays. The medical profession is therefore fully alive to these dangers. On the other hand, whereas the practitioner sees many examples of the effects of recessive mutations in man—the amaurotic familial idiot, the hæmophiliac, the alcaptonuric—he is seldom, if ever, able clearly to relate these to radiation effects. Thus the matter of genetic damage stands outside the field of practical medicine, and indeed so far has been largely a theoretical concern of eugenics.

Several new factors are at work which must ultimately alter this position. One is the recognition, now beyond dispute, that the genetic effects of radiation are cumulative. The increase in the mutation-rate is proportional to dose, no matter how long may be the period over which it is accumulated. It is estimated, for example, that a dose of 50 r. doubles the mutation-rate in man[1]. It will be noted that the tolerance dose, if regularly received over a reproduction life-time, represents approximately 750 r. It is in no sense a threshold value, and finds general acceptance only on the understanding that not more than 1 per cent of the population receives it regularly. In these circumstances the genetic effects are reckoned to be not more serious than other inevitable ones. The same effects would be produced by a dose of 75 r. incident on 10 per cent of the population. Another factor is a fuller realization of the high levels of radiation to which the population is being subjected as a result of the increasing popularity of X-rays and radium in a wide variety of uses. Especially is this true of the diagnostic and therapeutic uses. At one extreme, doses of the order of 10,000 r. are given in the deep X-ray treatment of malignancy, fortunately to sterile patients, and at the other a diagnostic screening after a barium meal accounts for 10–15 r. delivered directly to reproductive cells. Between the two stand a variety of conditions not in themselves fatal for which radiation is used; for example, ringworm and warts, and especially sterility in women, and on top of them come new treatments with radioactive isotopes. Finally, and most important of all, there stands in the background the sinister threat of an atomic war.

From the points of view of cancer and sterility, it is clearly in the interests of everyone to see that his accumulated radiation dosage both to tissue and reproductive cells is kept at the lowest possible level. He cannot know what the future has in store for him. From a national point of view, it is equally imperative that the level of peace-time radiation should be kept low. The people will be proportionately better able to tolerate the higher doses associated with preparation for, or the actuality of, an atomic war. The ultimate survival of a nation, if not indeed of the population of the world, may depend on just such a piece of elementary prudence as this. Peace-time levels cannot be ignored on the grounds that they are insignificant in relation to the radiation energy which may well be released in an atomic war. As Muller[2] has pointed out, much of the latter will not reach humans at all, and of the proportion which does, most of it will kill outright or sterilize. The insidious danger to the survival of the population lies in the breeding residuum, which will contribute a large number of recessive mutations to future generations. If these are already dangerously undermined in their genetic material by a wanton peace-time use of radiation by their forbears, the results will be serious.

These considerations require as a very minimum that public and scientific attention should be directed to the field of radiations and health in the broadest sense. In some measure, with this end in view, the Radiology Section of the British Medical Association at its Cambridge meeting held a symposium on the therapeutic applications of radioactive isotopes. The physical basis of the subject was presented in an opening paper by Prof. O. Frisch (Cavendish Laboratory), who dealt in particular with the various nuclear reactions which lead to the production of radioactive isotopes. Dr. A. S. McFarlane (National Institute for Medical Research) followed with a review of recent tracer applications, emphasizing the opinion that greater ultimate advantage will probably accrue from biochemical applications with the discovery of precise metabolic pathways in view, rather than from the more spectacular non-specific uses, as, for example, to measure blood-cell volumes or thyroid function.

The main contribution came from Prof. J. S. Mitchell, occupant of the newly created chair of radiotherapeutics in Cambridge. From his wide review covering all isotopes used therapeutically by external and internal administration, it is perhaps justifiable to refer in particular to his statements in relation to sodium-24, phosphorus-32, and iodine-131. These isotopes are usually administered internally, the first two being especially hazardous because, unlike most forms of therapeutic radiation, by virtue of their widespread distribution, they affect both reproductive and somatic cells. Iodine, on the other hand, is localized to the extent of 80 per cent in the thyroid gland, and this enables doses of 5,000 r. to be given which are effective in destroying glandular tissue in hyperthyroidism. The method is not to be preferred to surgery; but has a useful field of application where other considerations preclude surgery, or in recurrences after surgery. There is a definite risk of late carcinogenesis which is generally worth taking. Few thyroid carcinomas take up useful amounts of iodine, so that isotope therapy is of little value in most malignant conditions of this gland.

Phosphorus-32 given as inorganic phosphate spreads widely throughout the body. Although it is an important constituent of nucleic acid, and practically all tumours are highly nucleated, the differential concentration never approaches that of iodine in the thyroid and generally is too low to be therapeutically useful. However, supplementary X-rays may be used. Prof. Mitchell stressed particularly the value of chemotherapeutic research directed to the synthesis of phosphorus compounds which will become localized in tumour cells. The concentration factor may be increased by local injection of the drug, and the biological half-life of the isotope may be prolonged. The latter incidentally is a composite function of the physical half-life and the excretion-rate. For phosphorus-32 it is estimated to be 11 days for body phosphorus and 6·3 days for thyroid iodine, which compares with physical half-lives of 14 and 8 days respectively.

Phosphorus finds its most effective application in generalized conditions, such as polycythæmia vera and the leukæmias. For the former it is now the treatment of choice, 6–8 millicuries being sometimes effective in a single dose. Generally, however, the disease is kept in control by repeated treatments. The isotope is easily given, the results are better than with external radiation and there are no toxic reactions. It is of interest to note from the hazard point of view that a single dose of 8 millicuries of phosphorus-32 equally distributed in a 70 kgm. adult delivers 70 r. The danger may be observed by the fact that 10 per cent of polycythæmia cases in any event develop into chronic leukæmias; but a few acute leukæmias have been observed after phosphorus treatment. Here again, in Prof. Mitchell's view, the general clinical picture usually justifies the risk.

The initial popularity which phosphorus-32 enjoyed in the treatment of myeloid leukæmia seems to be passing. The high doses used are associated with serious risk to reproductive organs, bone marrow and lymphoid tissue. Most of the isotope is ultimately excreted through the kidneys, and insufficient information is available about remote renal effects. Isotope treatment without supplementary X-rays is valueless in lymphadenoma (Hodgkin's disease), in acute leukæmias of any kind and in tumours. The same remarks apply to sodium-24.

A lively discussion followed, from which it was obvious that the audience much appreciated in particular Prof. Mitchell's survey and shared his cautious attitude in the present limited state of our knowledge. Among various hazards discussed was that arising from the inhalation of particulate radioactive matter. This is present, for example, in laboratories carrying out incinerations of carbon-14 compounds. A minute amount of isotope may ultimately exceed the carcinogenic dose at a point of focus in the lung, since the physical half-life is much longer than the life-span of the individual.

A. S. McFarlane

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[1] Ellis, F., *B.J. Radiol.*, 1, 21 (1948).

[2] Muller, H. J., *Bull. Atom. Scientists*, 267 (Sept. 1947).

OBITUARIES

Mr. P. J. Barraud

It is with deep regret that many of his friends and colleagues will have received the news of the death on August 9, after a long illness, of Mr. P. J. Barraud, at a nursing home at Bournemouth. I first came to know Mr. Barraud, as did a number of others in the Government of India Bacteriological Service, as entomologist attached to the Central Laboratory, Busra, during the latter part of the Mesopotamian campaign in the First World War; but he had earlier in the War done valuable work in the R.A.M.C. in Salonica and Palestine, where he received his commission as captain. Later, in 1922, Barraud was appointed entomologist on special duty under the Indian Research Fund and attached to the Central Research Institute, Kasauli, to carry out research and make a comprehensive survey of the culicine mosquitoes of India, a subject which at the time was very much in need of revision.

Between 1922 and 1932 Barraud published some forty papers describing systematically group after group of mosquitoes with descriptions of large numbers of new species, the final results being published in 1934 as the volume in the Fauna of India series, "Megarrhine and Culicine Mosquitoes of India", a work which was almost unique in its scope and clarity of treatment and which still remains the most comprehensive treatise on Oriental Culicidæ yet published. From at most a few score of recognized species Barraud's work resulted in the description of the adults and early stages of nearly 250 species. At one time he had some difficulty in finding names for all the new species he was describing; and at the present time, out of about 250 total species known from India, more than sixty will be found under Barraud's name as describer.

When in 1925–27 the Kala Azar Commission was formed to investigate the method of transmission of this disease, Barraud was selected as one of its members, and during the time that the Commission was at work he contributed many papers in his own name and jointly with that of other members relating to kala azar and the sandfly *Phlebotomus argentipes*. Besides his more purely laboratory work, Barraud took a great interest, and played an active part, in the training of officers and other staff in the malaria courses held at Delhi by the then Malaria Survey of India (now Malaria Institute of India), and in this connexion he was the author of a very helpful practical entomologist's course for students of malariology (Health Bulletin Series No. 18, published by the Government of India).

After his retirement at Colehill and until his health failed, Barraud played a very active part during the Second World War in local salvage and other local war activities, and was vice-chairman of Colehill Parish Council. He was not only very highly esteemed by his colleagues in India, but also remained the friend of many of them up to the time of his death. His unassuming kindness and interest in those he came in contact with made him a general favourite socially, and he was a very fresh and companionable friend. He entered with zest into the work and interests of those whom he knew and would take endless trouble to help where his services could be brought usefully to bear. S. R. CHRISTOPHERS

Prof. C. Perrier

NEWS has been received of the death of Prof. Carlo Perrier, professor of mineralogy in the University of Genoa, Italy. Prof. Perrier was born on July 7, 1886, in Turin. He studied in that city and obtained his doctorate in chemistry at the University of Turin. Shortly thereafter he worked for some time in the laboratory of Baur in Zurich on physical chemical problems. On his return to Italy his interest turned to mineralogy, and he joined the school of F. Zambonini.

In 1926 he became professor of mineralogy in the University of Messina, and later he moved to Palermo and finally to Genoa. His work was mostly on crystallochemistry, and he brought to it a remarkable analytical skill and a deep knowledge of crystallography.

Perrier had a wide range of interests and a versatile mind, and when the occasion arose, he was quick to apply his various skills to new problems. Noteworthy among these were the study of technetium carried out by radioactive methods in Palermo in 1936–37 and the investigation by radioactive tracers of some biological and chemical problems. His merits were recognized by membership of several Italian learned societies, including the Academy of the Lincei.

He was a loyal friend and a good teacher, and his untimely death will be deeply regretted by everyone interested in the future of science in Italy.

NEWS and VIEWS

St. Anthony's College, Oxford

AN anonymous Frenchman has given £1,250,000 to the University of Oxford for the foundation at once of a new residential college, with the ordinary status of an Oxford college. Its name is to be St. Anthony's; and its head is to be called the 'warden'. It will start with seven or eight fellows and about fifty graduate and undergraduate members. It will be governed at first by the warden and fellows in conjunction with a St. Anthony Foundation, called into existence recently to carry out the benefactor's wishes. It will be accommodated in the first large house with grounds that can be secured in the vicinity of the University, so that this generous new venture may become visible in the life-time of its founder. He himself has little connexion with England and none with Oxford. His name, if disclosed, would convey nothing to the academic world; but, like Cecil Rhodes, he has admired Oxford men in positions of responsibility all over the world, and has become convinced that the British system of education has promoted initiative and strengthened the moral qualities of students better than any other. Again, like Rhodes, he is anxious that men from overseas should go to Oxford. He has asked, therefore, that in the new St. Anthony's College a substantial proportion of the places available should be kept for qualified graduates from French universities. To encourage undergraduate members to come from France in far greater numbers in the future than they have done hitherto, he has offered a further £250,000 to be divided among any existing Oxford colleges that propose to build additional sets of rooms for their men, provided that in these new sets one third of the places are kept for Frenchmen.

The new proposal was welcomed in a hastily summoned Congregation at Oxford on September 15. St. Anthony's will have the uphill task of all new educational institutions at the present time; but if it contributes something fresh and vigorous to Oxford academic life, as have all the colleges founded in the past hundred years—the five women's colleges, Keble and Nuffield Colleges and St. Peter's Hall—it will do good work. It is a mistake to think that Oxford has all the colleges it needs and that benefactors would be wiser in giving their money to the University itself for furthering teaching and research than to the colleges to strengthen their tutorial system and collegiate activities. This is exactly the time when new colleges are wanted and when some of the existing colleges need further endowment if they are to retain to the full the tutorial system that is so excellent a part of Oxford life. Relative to even the richer colleges, the University in its role of promoter of teaching and research is very well off. It has its own endowments. It has a substantial income from the colleges (which contribute anything from a few hundreds to about £30,000 yearly, according to the college's capacity to pay) and a large one from Government through the University Grants Committee. Colleges, on the other hand, get nothing from the central body of the University and nothing directly from any Government source. They have their endowments; but the increases in their incomes from these sources have, in recent years, lagged behind those of their outgoings. It is on the colleges that the main burden of catering for the large increases in the numbers of men and women in recent years has fallen. It is good, therefore, that St. Anthony's College has been founded. It is hoped that its foundation may stimulate other benefactors to help other colleges as they go forward to their post-war tasks.

Administration and Anthropology

THE Frazer Lecture in Social Anthropology delivered before the University of Liverpool on October 23, 1946, by Dr. E. W. Smith, has now been published under the title "Plans and a People —A Dynamic Science of Men in the Service of Africa" (London: Lutterworth Press, 1948. 3*s*. 6*d*. net). Dr. Smith reviews first some developments in anthropology since 1908, stressing particularly that the study of acculturation in Africa is very largely the study of a disintegrating society and that our prime purpose in social anthropology is to study African society for its own sake, to understand how its component parts function, what changes are taking place in it and in what directions it tends to develop. Delay in publication has enabled Dr. Smith, in succeeding chapters on the new dynamic Colonial policy, advances in sociological research and the place of anthropology in planning, to take account of events since the address was given, and to assess how far the purpose of government is now not merely the maintenance of security and order but also the general social betterment of the people, and the extent to which the five-year and ten-year plans which Colonial governments have drawn up in broad outline meet his criteria for success. He points out that the recent review of the Colonial Empire, 1939–47, recognizes the importance of research into the nature of native society and its institutions, and he believes that the International African Institute has not only influenced the progress of social anthropology in Great Britain but also the British Government's decision to finance scientific research in Africa. He agrees that the value of social anthropology to the arts of politics and administration depends upon its theoretical advance, but holds that there is room for anthropological study which is at once scientific in method and directed towards the solution of practical problems. While we may differ as to ultimate values, there is much common ground, and in the spheres of nutrition, education, and the improvement of economic and social conditions the anthropologist may join his efforts with those of other scientific workers.

University and Research Section of the Library Association

THE University and Research Section of the Library Association held its twelfth week-end conference during September 10–13 at the University of Birmingham. It was attended by ninety members, with Dr. Arundell Esdaile in the chair, and colleagues from Australia, Denmark, India, Sweden and Venezuela were present. The conference was welcomed to Birmingham by Dr. Wilfred Bonser, University librarian, who outlined the plans for the new University Library to be erected at Edgbaston. The chief speaker at the conference was Dr. S. R. Ranganathan, president of the Indian Library Association and formerly librarian of the University of Madras. Taking as his theme "The Challenge of the Field of Knowledge", Dr. Ranganathan pointed to the declaration made at the Royal Society Scientific Information Conference that in future librarians must be regarded as equal in standing to fellow men of science employed in research, industry and administration, and that they should receive comparable training facilities, rank and emoluments, as marking a definite advance. He showed how difficult it is for the librarian to satisfy the many needs of scholars—and especially of scientific workers—as the various fields of knowledge continually expand and overlap, particularly as seen from the point of view of library classification schemes. He demonstrated the principle and practice of the scheme known as Colon Classification, of which he is the author. During the week-end, visits were paid to the various sections of the University and other libraries at Birmingham, and the information departments of the Austin Motor Works and of Imperial Chemical Industries (Metals Division). The formal business of the annual general meeting of the Section on September 12 was followed by an account by Mr. C. C. Barnard, librarian of the London School of Hygiene and Tropical Medicine, of a visit to Hanover in May of this year as a representative of the Section at a conference of German librarians. The Medical Sub-Section held a meeting devoted to a symposium on cataloguing problems in medical publications, and also visited the Birmingham Medical Institute.

Elimination of Water from Wet Crude Oil

IN a paper on the "Elimination of Water from Wet Crude Oil obtained from Bituminous Sand by the Hot Water Washing Process", by K. A. Clark and D. S. Pasternack of the Research Council of Alberta, University of Alberta, Edmonton (Reprinted from *Canadian Chemistry and Process Industries*, 1947), the authors deal with this problem from two angles, by continuous settling at atmospheric pressure and settling under pressure with evaporation; they have carried out much laboratory work towards its solution. In the first case, wet crude oil from the separation plant is mixed with a diluent (either 'topped' crude oil with S.G. 0·85 or kerosene with S.G. 0·82) and subjected to continuous settling in a suitable laboratory plant (illustrated). A ratio of diluent to crude oil of 0·7 and settling temperature 180° F. results in reduction of water content from 40 to 11·5 per cent. It is found that boiling and frothing of wet diluted crude oil before feeding to the continuous settler improves settling of water by causing coalescence of finely dispensed water, hence increase in volume of water ultimately settling out. The authors emphasize that continuous settling of diluted crude oil is not the complete answer to total elimination of water and that a subsequent operation is required to reduce the amount of finely dispersed water to limits acceptable to a refinery. Concerning mineral matter normally associated with the crude oil, it is pointed out that sand and silt readily settle out; but finely divided clay matter is carried within the finely dispersed water, possibly acting as a stabilizer, and this does not settle out, presumably because the emulsion will not break down under the conditions obtaining.

In an attempt to formulate the 'subsequent operation' above, experiments were carried out with continuous settling under pressure at an elevated temperature; but it was found that heating diluted oil up to 323° F. in this way did not cause finely dispersed water to coalesce. Further, water which does settle, does so as a gelatinous emulsion which will not flow to the discharge valve unaided by mechanical means. Hot oil and water, as is well known, make an unsatisfactory mixture at all times; but it is worse than ever with bituminous sand oil. The conclusion reached is that pressure settling is not practicable, that atmospheric settling of diluted crude oil is the first step, to be followed by evaporation in a heater and steam separator; in this way a practically dry oil can be obtained from bituminous sand, one which can then be more easily refined.

An Attempt to Detect the Magnetic Field of a White Dwarf

DR. A. D. THACKERAY has now published a description of his attempts to test Blackett's prediction on the magnetic field of massive rotating bodies (*Mon. Not. Roy. Astro. Soc.*, **107**, 5 and 6; 1947). Blackett pointed out that the ratio between the magnetic moment and the angular momentum of the earth and sun was approximately the square root of the gravitational constant divided by the velocity of light, and that this also applied to 78

Virginis (*Nature*, **159**, 658; 1947). He also dealt with the application of this formula to the white dwarfs and showed that in the case of Sirius B the equatorial field might be as much as 3×10^6 gauss. Such a field should lead to Paschen–Back splitting of the hydrogen lines of the order of 50 A., and Thackeray gives a full description of his work with the 36-inch Common reflector at the Solar Physics Observatory, Cambridge, to detect this effect. Unfortunately, there is not a very wide choice of white dwarfs suitable for the experiment, and Wolf 1346, magnitude 11·3, was selected as it was attainable with a 1-prism slitless spectrograph attached to the 36-in. reflector. It was shown that Paschen–Back splitting of $H\gamma$ is unlikely to exceed 8 A. in this star, corresponding to an upper limit of 10^6 gauss. It is emphasized that there is need for greater spectral purity in a discussion of an apparent structure in the lines, which is independent of the polarizing analyser. When 40 Erid. B became accessible in September 1947 a 2-in. $f/1$ aspherical singlet, figured and lent by Dr. C. R. Burch, was attached to the Newall 25-in. refractor for an attempt with the Wood aluminized grating spectrograph. An hour's exposure without 'Polaroid' was obtained on September 25, showing $H\gamma$ only, but exposures of one hour on September 25 and 3½ hours on September 27 through the analyser failed owing to the formation of thick haze during exposure.

Recession of Glaciers

THE Royal Geographical Society has inaugurated its new *Research Series* with a paper by Prof. H. W. Ahlmann on glaciological research on the North Atlantic coasts (London: Royal Geographical Society, 1948. 7*s.* 6*d.*). Prof. Ahlmann puts together his own and other observations on glaciers in Norway, Iceland, East Greenland and Spitsbergen. All data point the same way, to a general recession, and the same is true in many other parts of the world. The present rapid shrinkage seems to be the last stage in a recession that began about two hundred years ago when the glaciers reached their maximum extension in historical, and perhaps in post-glacial, times. This recession has resulted too in a rise of sea-level, as noted by J. Thorarinsson, F. Bergsten and others. The increasing intensity of the recession is also shown by recent changes in the extension of the Arctic pack-ice, notably in the Russian Arctic and around Spitsbergen, the northward migration of fish and certain birds and the improved cereal prospects in Iceland. The phenomenon is so widespread that it would appear to be associated with climatic fluctuations. The chief meteorological cause is held to be due to increased ablation. Radiation plays a part; but conduction is more important in the smaller icefields and at lower altitudes. On the other hand, it is stated that in the high interior of the Greenland ice there has been no increased ablation or reduced thickness of the ice. The low-pressure area of the North Atlantic apparently has moved to the north in recent years, thus favouring the flow of warm air to the Arctic.

Gresham's School Natural History Society

THE twenty-sixth report of Gresham's School Natural History Society (1948) has just been received. Membership of the Society totals well over a hundred —an eminently satisfactory number for a school. The Society is divided into Archæological, Astronomical, Botanical, Entomological, Meteorological and Ornithological Sections, all of which carry out valuable field work and present reports and papers to the Society. In the present report there are: (1) a survey of the flora of Holt and district, with an exhaustive list of plants observed; (2) an account of the surrounding insect fauna, together with lists of Lepidoptera and Orthoptera; (3) a descriptive account of the birds of the area, with a very comprehensive list and a detailed study of a fulmar colony. Extracts of papers submitted for the Holland-Martin Natural History Prizes (1944–47) are appended. The boys of Gresham's School are to be congratulated on their efficient and very valuable Natural History Society, which obviously encourages practical and field work to the utmost—a fitting basis for later work in natural history, and a great asset in their general education.

Dr. Franz Weidenreich on Human Evolution

A NUMBER of interesting papers by Dr. Franz Weidenreich are to hand. "The Trend of Human Evolution" is published in *Evolution* (**1**, No. 4; Dec., 1947), and "Some particulars of skull and brain of early hominids and their bearing on the problem of the relationship between Man and the Anthropoids" appears in the *American Journal of Physical Anthropology*, **5** (N.S.), No. 4 (Dec., 1947). In an article in the *American Anthropologist*, **45**, No. 1 (Jan.–March, 1943), Dr. Weidenreich once again affirms his belief that Neanderthal man was the ancestor of *Homo sapiens*. The majority of physical anthropologists will probably not agree with the theories set forth in "The Neanderthal Man and the ancestors of *Homo sapiens*", but nevertheless Dr. Weidenreich can never be ignored with impunity. The last article comes from the *Transactions of the New York Academy of Sciences*, Series II, **4**, No. 1 (Nov., 1941). It is a lecture on the site and technique of excavation of fossil man in Choukoutien, China. No anatomical details of the finds are given; but the student will find conveniently set out the story of the discovery and the excavation.

The Sondes Place Research Institute

THE Sondes Place Research Institute, Dorking, Surrey, of MacTaggart and Evans, Ltd., industrial consultants, is described briefly in an illustrated booklet which this firm has issued. There are fifteen laboratories, besides offices, stores, dark room, library and semi-scale building and workshops. The Analytical Laboratory and the Physical Testing and Cement Laboratories are service laboratories carrying out analysis and testing for the rest of the organisation and to some extent for clients. The Spectroscopy and Microscopy Laboratories and the dark room, as well as the X-ray Analysis Laboratory, function both as service departments and as research laboratories, but the main chemical laboratory is used exclusively for research and development. The Physical Laboratory is used mainly for physico-chemical research and for determining physical constants, while the Electronics Laboratory deals with the application of electronic methods and servo-mechanisms to industry. Work is carried out either for a fixed fee, on a time basis, or for a monthly or yearly retainer; during the past few years problems relating to abrasives, adhesives, bricks, cast iron, cement and concrete, detergents, fibre boards, gelatine and glue, gypsum, lime, linoleum substitute, mineral oils, paint, plastics, printing, synthetic organic chemicals, strip steel, etc., have been handled.

Applications of Electronics to Research and Industry

A SYMPOSIUM on the applications of electronics to research and industry is being arranged by the Electronics Section of the Scientific Instrument Manufacturers' Association, to be held in the Caxton Hall, Westminster, S.W.1, during November 18 and 19. The subjects for discussion are: measurement of displacement by electronic methods; frequency measurement; electronics in computing; measurement of ionizing radiation; high-vacuum gauges; the *radio sonde* and its applications; industrial applications of ultrasonics; metal detection; electronic control of batching; electronics in spectroscopy and spectrophotometry; dynamic recording of mechanical strains; and picture telegraphy. There will be an exhibition of British electronic instruments in the Caxton Hall during the period of the meeting. Particulars and tickets of admission can be obtained on application to the Secretary.

Conference on Dust in Industry

THE Society of Chemical Industry is arranging a Conference on Dust in Industry, which will be held in the University of Leeds during September 28–30. The papers are being arranged in four groups, dealing with physical characteristics and estimation of dust (chairman, Prof. H. V. A. Briscoe), practical aspects of the dust problem (chairmen, Mr. Julian M. Leonard and Mr. A. V. Hussey), fire and explosion hazards (Sir Reginald Thomas), and health hazards (Prof. E. C. Dodds). Further particulars can be obtained from the General Secretary of the Society, 56 Victoria Street, London, S.W.1.

Colonial Services Appointments

THE following appointments in the Colonial Services have been announced: R. B. Symington, agricultural officer, Northern Rhodesia; F. W. Champion, assistant conservator of forests, Tanganyika; P. A. Daley, assistant conservator of forests, Nigeria; D. G. Ellis, assistant conservator of forests, Nigeria; M. Gane, assistant conservator of forests, Tanganyika; G. S. MacPherson, assistant conservator of forests, Gold Coast; H. Sanders, assistant conservator of forests, Nigeria; J. R. T. Hazell, geologist, Nigeria; C. V. Cutting, analytical chemist, Tung Experimental Station, Nyasaland; D. A. Donald (agricultural officer, Fiji), senior agricultural officer, British Solomon Islands Protectorate; T. G. Strangeways (agricultural officer, Northern Rhodesia), senior agricultural officer, Hong Kong; W. O. Sunman (assistant to the Director of Agriculture, Kenya), assistant director of agriculture, Kenya; G. W. Chapman (assistant conservator of forests, Cyprus), senior assistant conservator of forests, Cyprus; N. Harris (geologist, Uganda), senior geologist, Uganda; W. G. Beaton (deputy director of veterinary services, Nigeria), director of veterinary services, Nigeria.

The Night Sky in October

NEW moon occurs on Oct. 2d. 19h. 42m., U.T., and full moon on Oct. 18d. 02h. 23m. The following conjunctions with the moon take place: Oct. 4d. 11h., Mercury 4° S.; Oct. 5d. 18h., Mars 1° N.; Oct. 8d. 02h., Jupiter 4° N.; Oct. 27d. 17h., Saturn 4° S.; Oct. 29d. 07h., Venus 2° S.; Oct. 31d. 00h., Mercury 0·5° N. In addition to these conjunctions with the moon, Venus is in conjunction with Regulus on Oct. 5d. 21h., Venus 0·4° S., and on Oct. 8d. 20h. Venus is in conjunction with Saturn, Venus 1·1° S. Mercury, in inferior conjunction on Oct. 20 and stationary on Oct. 28, is unfavourably placed for observation during the greater portion of the month. On Oct. 31 the planet rises 1h. 40m. before the sun and can be seen in the eastern sky. Venus rises at 2h., 2h. 40m. and 3h. 15m. at the beginning, middle and end of the month, respectively, and can be seen in the morning hours, stellar magnitude −3·6, the visible illuminated portion of disk varying between 0·64 and 0·74. Mars sets a little more than an hour after the sun during October and is not well placed for observation. Jupiter sets at 20h. 36m., 19h. 50m. and 18h. 57m. on Oct. 1, 15 and 31, respectively, and is visible in the western sky (stellar magnitude −1·6) for some time after sunset. Saturn rises at 2h. 30m. and 0h. 50m. at the beginning and end of the month, and can be seen in the morning hours, stellar magnitude 0·9. Occultations of stars brighter than magnitude 6 are as follow: Oct. 14d. 21h. 47·8m., ψ^3 Aquar. (*D*); Oct. 21d. 00h. 16·0m., 32 Taur. (*R*); Oct. 25d. 03h. 47·2m., ω Canc. (*R*); *D* and *R* refer to disappearance and reappearance, respectively, and the latitude of Greenwich is assumed. The Orionid meteors are due about October 16–24, but moonlight will partly interfere with observation of this shower.

Announcements

PROF. M. G. EVANS, professor of inorganic and physical chemistry in the University of Leeds, has been appointed to the chair of physical chemistry in the University of Manchester.

MR. W. T. COOPER, for the past five years scientific editor and head of the Publications Department of the British Coal Utilisation Research Association, has been appointed assistant secretary (editorial) of the Institute of Fuel.

THE third Fleming Memorial Lecture of the Television Society will be delivered by Mr. Arthur Blok, who will give some personal recollections of Sir Ambrose Fleming. The Lecture will be given at the Royal Institution, London, W.1, on September 29, at 6.30 p.m.

IT is announced that, owing to lack of funds, the International Office for Nature Protection cannot continue its work in Holland, and Dr. J. H. Westermann has resigned from the post of acting director. Following the decision of the General Council, the Bureau was recently transferred from Heerengracht 540, Amsterdam, to the Royal Natural History Museum, 31 rue Fautier, Brussels, where it will be under the supervision of Prof. V. van Straelen, vice-president of the Office.

Two courses in photoelasticity are being arranged at University College, London; one will consist of twenty-eight weekly lectures, with periods of laboratory work during the second and third terms of the session; the other, ten periods (lectures and demonstrations). Full particulars can be obtained from Col. H. T. Jessop, Photoelastic Laboratory, University College, London, W.C.1.

ERRATUM.—Referring to the communication entitled "A Simple Result in Quadrature" (*Nature*, August 7, p. 215), Sir K. S. Krishnan states that in the last entry of column 2 of the table, the numerator should read

$$(2\cos\tfrac{1}{2}v)^{\alpha+\beta-2}\exp\{-\tfrac{1}{2}iv(\alpha-\beta)\}.$$

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Lunar Tidal Oscillations in the Ionosphere

USING the well-known radio methods of upper atmospheric exploration, Appleton and Weekes[1] showed that the E-layer of the ionosphere is subject to an unexpectedly large lunar tide. The tide was found to be semi-diurnal in character, of the order of 1 km. in amplitude, the maximum heights being reached about $\frac{3}{4}$ hr. before the lunar transits.

More recently Martyn[2] has shown that the ionospheric observations made at the equatorial Huancayo station of the U.S. Department of Terrestrial Magnetism indicate a semi-diurnal lunar tide for the F_2-layer, also of very substantial magnitude, and has shown that this lunar oscillation can be observed in both the heights and critical frequencies of that layer.

Counting the magnitude and phase of the semi-diurnal tides in the E-layer as established for the location of south-east England, we have therefore examined F_2-layer ionospheric data for the same location in order to discover whether there is any variation of phase and amplitude with height. It was also considered of interest to find out whether the lunar tide in the F_2-layer could be detected for a station as far removed from the equator as latitude $51\frac{1}{2}°$ N.

As the material for analysis we have used the Slough hourly values of both the F_2-layer critical frequency and also of a quantity, h_m, the height of the maximum ionization level of the F_2-layer. Values of h_m were calculated by a method we have previously described[3]. Semi-diurnal lunar oscillations have been found in the values of both f_{F_2} and h_m. The amplitude of the oscillation in the case of f_{F_2} is about 0·05 Mc./s., the maximum being reached shortly before the time of lunar transit. The amplitude of the oscillations in the case of h_m is about 2 km.; but here the maximum is attained approximately mid-way between lunar transits. Thus the lunar tidal effects in f_{F_2} and in h_m are seen to be approximately out of phase, a result not unexpected from our previous study of F_2-layer phenomena generally. What is unexpected, however, is that the lunar diurnal *height* variations for the F_2-layer are found to be entirely different in phase from those previously observed for the lower level of the E-layer, indicating an alteration of phase of lunar height oscillation with change of ionospheric level. An investigation of corresponding effects in h'_{F_2} data, which relate to an intermediate level, indicate a phase maximum at a time intermediate between those found for the E-layer and for the level of h_m for the F_2-layer.

E. V. APPLETON

Dept. of Scientific and Industrial Research,
London, S.W.7.

W. J. G. BEYNON

University College,
Swansea.
Sept. 8.

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[1] Appleton, E. V., and Weekes, K., *Proc. Roy. Soc.*, 171, 171 (1939).

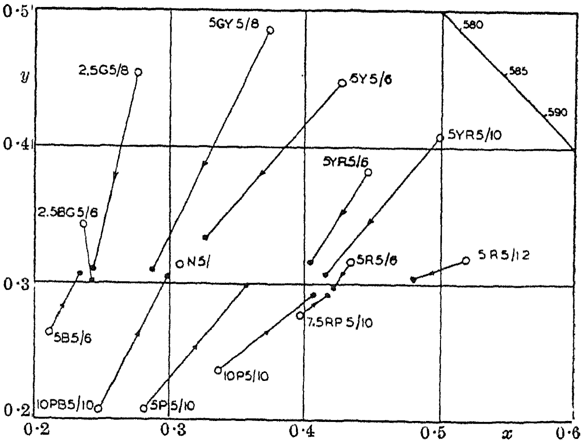
[2] Martyn, D. F., *Proc. Roy. Soc.*, 189, 241, 190, 273 (1947).

[3] Appleton, E. V., and Beynon, W. J. G., *Proc. Phys. Soc.*, 52, 518 (1940).

Apparent Colours of Surfaces of Small Subtense

THE investigations of Hartridge[1] and others have substantiated the early conclusion of König[2] that the eye behaves as if tritanopic for coloured stimuli of small subtense, and it occurred to me that it would be of both theoretical and practical interest to determine the actual colours assumed under controlled conditions by small coloured surfaces. The first results are so striking a confirmation of König's conclusions that they are presented here as a preliminary report.

Small circular patches of a number of Munsell colours chosen from the 5-plane were presented against a black background (reflectance 2·6 per cent) singly and in random order to an observer seated at such a distance that they subtended 2 minutes of arc. The observer was provided with a chart having larger samples of all the Munsell colours in the 5-plane, systematically arranged, and a black mask with which any one colour could be isolated. The sample and the comparison chart were separately illuminated by 180 lumens m.$^{-2}$ of artificial daylight similar in colour to C.I.E. source '*C*'. The observer was encouraged to be critical and to interpolate between the even values of chroma available; there was no possibility of interpolating between hues.



The figure is a portion of the C.I.E. mixture diagram showing the co-ordinates of the sample colours by open circles, and the mean location of the apparent colours at 2′ subtense by black dots. The (Munsell) neutral point is also indicated. Eight sets of observations by one observer are represented in the means.

Three main results will be noted: (1) the apparent displacements are in general directed towards or away from the short wave-length extremity of the spectrum locus ($x = 0{\cdot}17$, $y = 0{\cdot}01$); (2) the apparent colours lie closely about a line which if produced would cut the spectrum locus at about 491 and 630 mμ; (3) blue, green and blue-green are confused, as are also purple, red-purple, and orange; (4) yellowish-green, grey and purplish-blue are confused. The last two items, and indeed the entire picture, are in full accord with König's description of tritanopia. As an independent check of item (4), the Munsell colours lying near the straight line joining 5GY5/8 and 10PB5/10 were mounted side by side in order on the same piece of black card. At the experimental distance they appeared very nearly identical; though the extreme colours were just distinguishable. The three colours 2.5G5/8, 2.5BG5/6 and 5B5/6, similarly mounted, appeared identical.

A second observer, completely unacquainted with the Munsell colour system, obtained results similar to those shown in the figure, though with more scatter. Apparatus is being constructed to check these findings by methods less open to objection on psychophysical grounds; but of the general picture there seems no doubt.

W. E. KNOWLES MIDDLETON
National Research Council,
Ottawa. April 13.

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[1] Hartridge, H., *Phil. Trans.*, B, 592, 519 (1947).

[2] König, A., "Physiologische Optik", 396 (Leipzig, 1903), quoted in Wright, W. D., "Researches on Normal and Defective Colour Vision", 333 (London, 1946).

Electronic Digital Computers

A SMALL electronic digital computing machine has been operating successfully for some weeks in the Royal Society Computing Machine Laboratory, which is at present housed in the Electrical Engineering Department of the University of Manchester. The machine is purely experimental, and is on too small a scale to be of mathematical value. It was built primarily to test the soundness of the storage principle employed and to permit experience to be gained with this type of machine before embarking on the design of a full-size machine. However, apart from its small size, the machine is, in principle, 'universal' in the sense that it can be used to solve any problem that can be reduced to a programme of elementary instructions; the programme can be changed without any mechanical or electro-mechanical circuit changes.

The essential parts of such a machine are: (1) a store for information and orders; (2) various arithmetical organs (for example, adders, multipliers); (3) a control unit[1].

The present machine contains the minimum set of facilities for a universal machine, namely: (*a*) If x is any number in the store, $-x$ can be written into a central 'accumulator' A; or x can be subtracted from what is in A. (*b*) The number A can be written in an assigned address in the store. (By means of (*a*) and (*b*) addition or direct writing into A can be programmed.) (*c*) The content of A can be tested for whether $x \geqslant 0$, or $x < 0$; if $x < 0$ the order standing next in the store is passed over. This gives the essential power of branching routines. (*d*) Control can be shifted to an assigned order in the table. (*e*) The machine can be ordered to stop.

The capacity of the store is at present only 32 'words', each of 31 binary digits, to hold instructions, data and working. Hence only simple arithmetic routines devised to test the machine can be run. Examples of problems that have been carried out are: (1) Long division by the standard process. (For $(2^{30} - 1)/31$, this took $1\frac{1}{2}$ seconds, the quotient being given to 39 significant binary figures of which the 13 least significant, to the left of the binary point, were zero, since 31 is a factor of $2^{30} - 1$.) (2) H.C.F. by the standard process. (For 314,159,265 and 271,828,183, which are co-prime, approximately 0·5 second.) (3) Factorizing an integer. For (3) the method was deliberately chosen to give a long run the result of which could be easily checked. Thus the highest proper factor of 2^{18} was found by trying in a single routine every integer from $2^{18} - 1$ downward, the necessary divisions being done not by long division, but by the primitive process of repeated subtraction of the divisor. Thus about 130,000 numbers were tested, involving some 3·5 million operations. The correct answer was obtained in a 52-minute run. The instruction table in the machine contained 17 entries.

It will, of course, be understood that it is intended to have other arithmetical facilities, as well as a much larger store, in a full-sized machine; and that even on the present machine quicker routines could have been used. At present routines are chosen with the sole object of testing the machine as thoroughly as possible.

The development of this machine has been very actively supported by the Telecommunications Research Establishment, Great Malvern.

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[1] For a fuller discussion see, for example, the Royal Society discussion on computing machines, summary in *Nature*, 161, 712 (1948).

Excitation Probability Functions of Atomic and Molecular Energy-Levels

IN the correlation of the electrical and spectroscopic properties of a glow discharge in a molecular or atomic gas, the need for a rough quantitative analysis of the kinetics of the excitation of the gas soon becomes apparent. In all but the simplest cases, no more than a rough analysis can be attempted with the present scanty experimental and theoretical knowledge of the interaction of slow electrons with atoms and molecules. It is the purpose of this communication to present an empirical form for the excitation probability functions of the atomic and molecular levels which seems to fit the few experimental curves fairly closely, and at least provides a basis for calculation where previously only generalized discussion was possible.

In principle, the excitation probability functions of atomic or molecular levels may be calculated from quantum mechanics. However, in actual fact, very few atoms and molecules have been considered[1]. In any event, serious theoretical difficulties exist in calculating the excitation probabilities for collisions with slow electrons—the interesting case from the point of view of glow discharge—where the Born approximation becomes invalid. Apart from these difficulties, it is necessary that the wave functions of the ground and excited states should be known. The wave functions of very few of the energy states of atoms and molecules have, in fact, been calculated. The quantum-mechanical method does not express the excitation probability function in a form which is readily applicable to discharge problems. Blackett[2] made an interesting semi-classical approach to the subject using the principles of conservation of energy and momentum. This, however, was limited and exploratory.

The shapes of excitation functions observed experimentally for singlet and triplet atomic levels from a singlet ground state are different[3]. The singlet excitation function rises from zero at the energy of the level concerned to a broad maximum somewhat above it, while the triplet excitation function rises from zero at the energy of the level concerned to a sharp maximum much closer to the level. The difference in shape is due to electron exchange being necessary for change of multiplicity.

An examination of the general shape of the experimental excitation functions suggests that they may be represented by:

$$s_1(V) = C(V - E_{AB})^{1/2} \exp [-L(V - E_{AB})], \quad (1)$$

where $s_1(V)$ is the excitation probability as a function of the energy V of the exciting electrons; E_{AB} is the energy separation of the ground (A) and the excited (B) states; L, an adjustable constant, controls the position and shape of the maximum ($s_{\max}$ occurs at $V = \frac{1}{2L}$); C is a scaling constant. Such a function has been fitted to the experimental curves for singlet and triplet excitation of atoms. The fit is comparable to that of the theoretical curves in cases where they have been calculated.

If (1) represents the excitation probability function for a first-kind collision between an atom and an electron, it can be applied in the relation of Klein and Rosseland[4], namely:

$$s_2(V - E_{AB}) = \frac{p_A}{p_B} \left[\frac{V}{V - E_{AB}}\right]^{1/2} s_1(V), \quad (2)$$

for the probability of the microscopically reversible case of a second-kind collision between an excited atom and an electron. p_A and p_B are the quantum weights of the states A and B respectively. From (1) and (2) we have:

$$s_2(V - E_{AB}) = C \frac{p_A}{p_B} V^{1/2} \exp[-L(V - E_{AB})]. \quad (3)$$

(1) and (3) predict the maxima of s_1 and s_2 to fall at energies which are greater by equal amounts than the energies of B and A respectively.

In the case of molecules, both experimental and theoretical knowledge is more scanty than in the case of atoms. The excitation functions of the nitrogen triplet *bands* have been investigated by numerous workers. These excitation functions are not necessarily the excitation functions of the upper levels concerned, however, as this assumes a direct excitation mechanism to these levels, and radiation as the only depopulating mechanism. As has been suggested previously[5], this assumption can by no means always be made, especially in the case of the triplet bands.

The excitations of both atomic lines and molecular band-systems are similar in that the orbital electrons in each case are the governing factor. We may therefore suppose the general shape of the excitation functions for molecular electronic levels to be the same as for atomic levels, and seek to apply the empirical function suggested above. In the molecular case, unfortunately, there are less experimental data of excitation functions (for molecular *levels*) to which the empirical equation may be fitted. Consequently, calculations must be of a more general nature than in the case of atoms. Study of the curves represented by (1) show that in cases where the experimental excitation functions are unknown, choice of $L \sim 1$ for triplet excitation functions and $L \sim 0 \cdot 1$ for singlet excitation functions enables first approximation analytical progress to be made. The postulation of a function such as (1) is necessary if any quantitative calculation is to be attempted on the excitation mechanisms in a molecular gas, when excited by electrons of an energy distribution $n(V)dV$, as exists, for example, in glow discharge. Such an analysis has been made of the excitation kinetics of nitrogen, the results of which are to be published shortly.

The choice of the suggested function has no theoretical basis. Its justification is in its fitting the experimental curves and of being of convenient analytical form. It enables some progress to be made in correlating electrical and spectroscopic data from discharge, in connexion with which this work has been done.

I should like to express my thanks to Prof. R. W. B. Pearse for valuable discussion.

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[1] Mott and Massey, "Theory of Atomic Collisions", Chapters 11, 12. Massey and Mohr, *Proc. Roy. Soc.*, A, **132**, 605 (1931); **140**, 613 (1933). Penney, *Phys. Rev.*, **39**, 472 (1932).

[2] Blackett, *Proc. Camb. Phil. Soc.*, **22**, 56 (1924).

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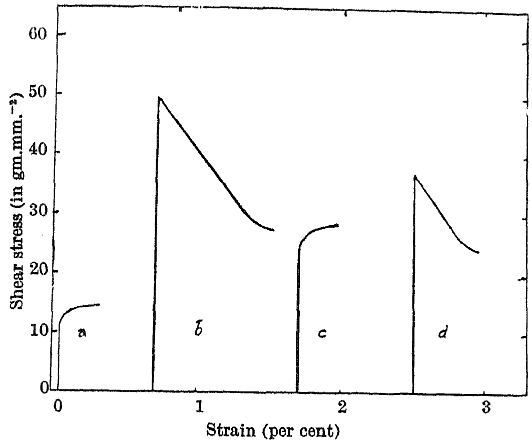
Thermal Hardening of Cadmium Crystals

By annealing a crystal of chemically pure zinc in the temperature range 0–300° C. after a small plastic extension ($\sim$1 per cent) had been given, Orowan[1],[2] found that the crystal could be made resistant to plastic deformation until a yield stress much higher than the previously determined 'normal' value was reached. The crystal would then suddenly yield and continue to extend plastically at the normal lower yield stress. On the other hand, a freshly strained crystal began to flow when retested as soon as the lower yield stress was reached. He termed the effect 'thermal hardening'. These effects remind one strongly of the yield phenomenon and strain ageing of iron, and the terms 'upper' and 'lower yield points', respectively, are suggested for the yield values belonging to the thermally hardened and freshly strained states.

Thermal hardening has been observed more recently by Smith[3] in spectroscopically pure cadmium crystals; however, whereas Orowan found the effect to be rare in zinc, Smith obtained it with every cadmium crystal he examined. We have found that cadmium crystals grown (by Andrade and Roscoe's fusion method[4]) in an atmosphere of pure argon give no sign of the effect; but marked thermal hardening could be produced consistently whenever the crystals were grown in nitrogen. It was also produced when argon contaminated by small amounts of nitrogen was used. Curve *a* shows a stress-strain curve from a crystal grown in pure argon and given a treatment designed to develop thermal hardening. The yield phenomenon, which is quite absent in this case, is clearly produced in a similarly treated crystal which has been grown in nitrogen (curve *b*); this second crystal produces the 'normal' type of curve, however, in which the yield phenomenon is absent, when it is tested in the freshly strained state (curve *c*).

Smith found that the value of the upper yield point varied markedly with λ, the angle between the axis of the applied tensile load and the glide direction, and a minimum was obtained in the range $\lambda = 40$–$45°$, where the upper yield point was only 5 per cent higher than the lower yield point. We have so far



Stress-strain curves of cadmium crystals. (*a*) Grown in argon; pre-strained 0·8 per cent; 40 min. at 200° C.; $\chi = 19°$, $\lambda = 30°$. (*b*) Grown in nitrogen; pre-strained 0·98 per cent; 50 min. at 200° C.; $\chi = 28°$, $\lambda = 40°$. (*c*) Immediately retested after (*b*). (*d*) Grown in nitrogen: no pre-strain; 90 min. at 200° C.; $\chi = \lambda = 56°$. (χ = angle between slip plane and tension axis.) (λ = angle between slip direction and tension axis)

failed to confirm this result; thus we have observed a difference of 70–80 per cent in the yield-points on crystals with $\lambda \sim 40°$, which is as high as can be obtained in other ranges of λ.

A difference between thermal hardening and the yield phenomenon in iron is that the characteristic yield point is produced at the first time of testing with iron, whereas with a cadmium crystal the first curve is of the type of curve *c* and the yield point type of curve is not obtained until a thermal hardening treatment has been given. The difference may be due to handling a soft crystal. To confirm this, a cadmium crystal was mounted in the testing machine and annealed *in situ* before testing. The characteristic upper yield point was developed by this treatment (curve *d*), which shows that the preliminary straining treatment is not essential and that the difference mentioned above between thermal hardening and the yielding of iron is trivial.

A subsidiary effect noticed is that, with successive annealing treatments, both the upper and lower yield points rise above their previously determined values (see table). This was found to be due to the formation of a surface film on the cadmium crystals during annealing. Roscoe[5] has shown that the presence of a thin oxide film can raise the critical shear stress of cadmium, and we have confirmed this on cadmium crystals free from nitrogen; a critical shear stress of 12 gm.mm.$^{-2}$ was obtained when the crystal surface was clean and, by a light oxidation treatment, this could be raised to 30 gm.mm.$^{-2}$.

Effect of successive annealing treatments on the yield points of a cadmium crystal ($\chi = \lambda = 56°$)

Treatment	Upper yield point, τ_1, measured as resolved shear stress in gm.mm.$^{-2}$	Lower yield point, τ_2, measured as resolved shear stress in gm.mm.$^{-2}$	$\frac{\tau_1-\tau_2}{\tau_2} \times 100\%$
As grown	—	17·1	—
70 min. at 200° C.	33·4	20·2	65
Further 33 min. at 200° C.	32·8	20·6	59
Further 90 min. at 200° C.	41·0	21·8	88
Further 35 min. at 200° C.	42·8	23·3	83·5

A further similarity between thermal hardening and the yield phenomenon of iron is that nitrogen produces thermal hardening in cadmium, and the presence of small amounts of carbon or nitrogen in iron is associated with the yield phenomenon[6-8]. An explanation of the effects in iron, put forward recently by one of us[9], may thus be also applied to thermal hardening. It is considered that foreign atoms in solid solution migrate to dislocations, where they relieve stresses by altering locally the equilibrium lattice constants. A large force is then required to tear a dislocation from its cloud of solute atoms (upper yield point), and when a dislocation has in this way been freed it can migrate rapidly through the lattice under a smaller force (lower yield point). A freshly strained crystal contains free dislocations and shows no upper yield point; but, on annealing, the solute atoms can migrate to the free dislocations, anchoring them once more and causing the yield phenomenon to return.

We wish to thank Dr. C. L. Smith for helpful discussions, and Prof. D. Hanson and the Department of Scientific and Industrial Research for their interest and for providing facilities for this investigation.

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[2] Orowan, E., *Proc. Phys. Soc.*, **52**, 14 (1940).
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[4] Andrade, E. N. da C., and Roscoe, R., *Proc. Phys. Soc.*, **49**, 152 (1937).
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Limiting Diffusion Currents at Wire Electrodes

THE limiting current for an electrode reaction in aqueous solution, in which diffusion of the depolarizer to the electrode surface is the rate-determining factor, is generally treated[1] by assuming there to be present adjacent to the surface a diffusion layer of fixed thickness across which a linear concentration gradient is set up. On these assumptions, the limiting current is given by the expression:

$$I = \frac{ADnFC}{\delta} \times 10^{-3}, \qquad (1)$$

where I is the limiting current (amp.), A the area of the electrode surface (cm.^{2}), D the diffusion coefficient of the depolarizing ion (cm.^{2} sec.$^{-1}$), n the number of electrons involved in the electrode reaction, F the faraday, C the bulk concentration of the depolarizer (gm. ion per litre), and δ the thickness of the diffusion layer (cm.). This expression is found to hold satisfactorily for large electrodes, and δ has a substantially constant value for different depolarizers in unstirred solutions at constant temperature. The same relation has generally been considered to hold for wire electrodes, and since such electrodes are very convenient in practice and give well-defined limiting currents, they have been much used in voltammetric work.

During an investigation of the electrolytic oxidation of potassium ferrocyanide using small vertical wire anodes of constant diameter in unstirred solutions, we found that while the ratio I/AC was satisfactorily constant over a very wide variety of conditions, as required by equation (1), its actual value of *c.* 5×10^{-2} (at 20° C.) was very much higher than that

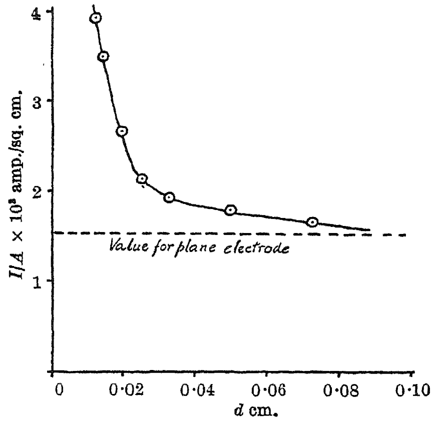

Fig. 1

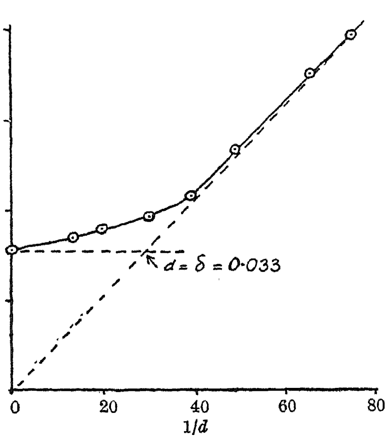

Fig. 2

of $2{\cdot}9 \times 10^{-2}$ (at 25° C.) found by Kolthoff and Laitinen[2] for the same system. In attempting to resolve this discrepancy, it was noted that these workers had used rather thicker wire electrodes than those employed in our investigation, and we have therefore made measurements with wire anodes of different diameters.

We have now found that the ratio I/AC increases rapidly with decreasing diameter when the wire becomes sufficiently thin. Some typical results are shown in Fig. 1 in which the limiting current density in amp./sq. cm. for the anodic oxidation of $0{\cdot}05M$ potassium ferrocyanide in phosphate buffer at 20° C. is plotted against the diameter d of the wire used. It may be noted that with the thickest wire used of diameter 0·0725 cm., the limiting current density is only slightly higher than that found for a plane electrode, but with decreasing diameter it increases, and below a diameter of 0·04 cm. the increase is very rapid indeed. In Fig. 2 the limiting current density is plotted against the reciprocal of the diameter, and it is seen that for very thin wires it becomes inversely proportional to the diameter; and it appears that:

$$I = \frac{ADnFC}{d} \times 10^{-3}. \qquad (2)$$

The intersection of the dotted lines representing the limiting cases (1) and (2) gives a value of δ of 0·033 cm. Other determinations of δ involve a knowledge of the diffusion coefficient of the depolarizing ion, about which there is usually considerable uncertainty. Early work[1] suggested a value of δ of about 0·05 cm., but Kolthoff and Laitinen[2] from a study of a number of reactions arrived at a value of 0·025 cm. Re-examination of their results, however, shows that their limiting current densities would be about 1·2 times the values for plane electrodes, owing to the diameter effect now reported; and if allowance is made for this, their results give a value of δ of 0·03 cm. (at 25° C.), which is in close agreement with that of 0·033 cm. (at 20° C.) obtained above.

The effect now reported appears to be a general one independent of the nature and concentration of the depolarizer used. In general, it is obvious that when the diameter of the wire approaches the thickness of the diffusion layer, equation (1) must fail, and indeed the diffusion must be of a cylindrical rather than a linear type. We have attempted to account for the experimental results by using the general equation for cylindrical diffusion (which does not of itself lead to any stationary state such as is experimentally observed) and inserting arbitrary boundary conditions; but these attempts have not led to any practically useful result. Empirically, a close fit to the experimental points can be obtained if equation (1) is formally retained and the diameter of the wire d replaced by $\sqrt{d^2 + \delta^2}$ in calculating the electrode area, and this may have some practical value for calculation purposes, although its physical significance is obscure.

The present results have two practical implications. First, in comparing results of limiting current measurements at wire electrodes, as is often done, the wires used must be fairly thick, or of the same diameter, or a correction factor must be introduced. Secondly, in designing electrodes to obtain very high limiting currents, as, for example, the platinum gauze electrodes used in electro-analysis, there is an obvious advantage in using the thinnest possible wire consistent with mechanical strength; our measurements show that the limiting current per unit length of wire becomes independent of diameter for very thin wires, and hence some saving of metal may be achieved by this procedure.

We are indebted to Mr. T. B. Grimley for much helpful discussion.

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[1] See Glasstone and Hickling, "Electrolytic Oxidation and Reduction", chapter 3 (1935); Kolthoff and Lingane, "Polarography", chapter 32 (1941).

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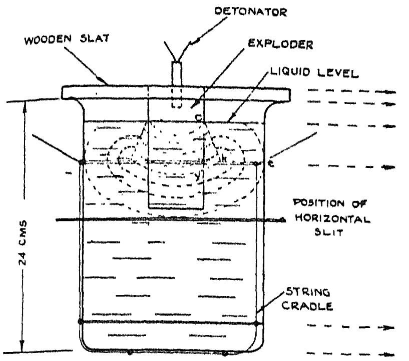
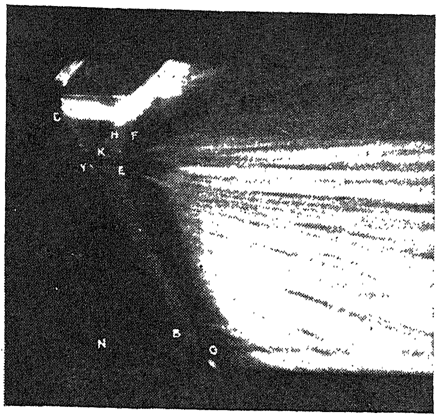
Detonation in Liquid Explosives

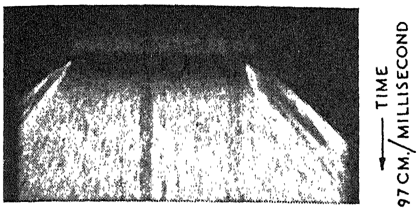
DURING the War a general investigation was commenced at the Road Research Laboratory, on the initiative of Dr. A. H. Davis, into the process of detonation in explosives, the programme including a photographic study of the detonation waves in transparent liquid explosives—the sensitivity of some of which can be varied by adjusting the constitution—and their relation to primers of different types and shapes. In the work, use was made of a new high-speed mirror camera to photograph the progress of the luminous detonation front inside transparent liquid explosives. A unique feature of the camera was the employment of two independent lens assemblies, each consisting of a telephoto field component focusing on to a spectrographic slit. The slits themselves were focused, via a four-sided rotating mirror, on to a photographic film located in cylindrical guides. The fields of the two slits were arranged to intersect at right angles in the object plane, approximately 30 ft. from the camera. Further, by means of a suitable arrangement of plane mirrors between the rear lenses and the film, images from the two slits were arranged to record on different areas





TIME : 97 CM/MILLISECOND

RECORD FROM VERTICAL SLIT



RECORD FOR HORIZONTAL SLIT

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of the same film. Use was made in this connexion of adjacent sides of the mirror block. In this manner it was possible to record simultaneously in two directions at right angles. The maximum recording speed was approximately 100 cm. per sec., with a time resolution of 1 microsecond.

A record obtained during the detonation of a 14-lb. charge of the transparent liquid explosive diglycol dinitrate, using a 12-oz. cylindrical tetryl primer, is reproduced herewith. The vertical slit was focused on the axis of the glass beaker used to contain the explosive, while the horizontal slit covered a section slightly below the bottom of the primer. To facilitate interpretation, the sketch of the charge is reproduced to the same linear scale as the records.

Referring to the record from the vertical slit, the flash from the detonator occurs first in time, followed by extensive luminosity from the section of the primer between the underside of the primer support and the level of the liquid. The flame front from this zone, travelling towards the camera, is later deflected upwards by the glass wall of the beaker. The boundary *CYB* on the record indicates the passage of the detonation front, first down the side of the primer and afterwards, with a slight decrease in velocity, down the axis of the beaker. During its passage from *c* to *y* along the primer, the detonation front has spread, to a limited extent only, into the liquid explosive, as sketched on the diagram. This encroachment is indicated by the boundary *CK* on the record.

On a circle concentric with the charge axis, and passing through the point *k*, a new detonation process has originated in the liquid. This has combined with the original wave to form a front of the shape sketched. The upward movement of this front is recorded as the boundary *KH*. When the detonation wave reaches the glass at *e*, luminosity ceases for a few microseconds, before the commencement of burning in air. This corresponds to point *E* on the record. As the expanding front shatters the glass, the boundary *FEG* is developed. From a mathematical analysis of this boundary the shape of the detonation wave can be derived. (The tail *NB* is due partly to reflexion from the convex base of the beaker, and partly to refraction at the curve in which the wall of the beaker meets the base.)

The horizontal slit records nothing until the detonation front in the liquid crosses its field. The curved boundary again gives a key to the shape of the wave, but in this case a correction must be made for refraction in the undetonated liquid. The record as it stands gives the impression that the detonation front has been temporarily contained by the glass !

Using this technique the critical primer/charge diameter ratio necessary to give complete detonation was investigated, and the effect of shaping the primer examined. The horizontal slit was found to be invaluable in the elucidation of the more complex detonation processes associated with shaped primers.

Some of the records obtained suggested that diglycol dinitrate has one or more low orders of detonation of the kind referred to recently by Jones and Mitchell[1]. Unfortunately, the luminosity associated with them was insufficient to record on the fastest film available, and the detonation process had to be reconstructed from the envelope of the after-burning, which was generally sufficiently luminous to record.

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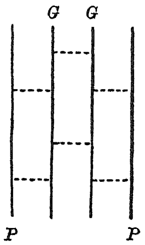
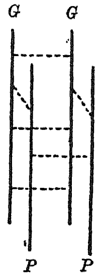
[1] Jones, E., and Mitchell, D., *Nature*, **161**, 98 (1948).

Some Peptides from Insulin

BY oxidation with performic acid, the insulin molecule can be split into its separate polypeptide chains[1]. It has now been possible to prepare two fractions from the oxidized insulin : fraction *A* contains only glycine terminal residues and no arginine, histidine, lysine, phenylalanine or threonine ; fraction *B* contains 97 per cent phenylalanine terminal residues and all the amino-acids that are present in insulin. The yield of fraction *A* is more than 25 per cent of the original insulin, indicating that it represents more than one of the peptide chains of the insulin. The yield of fraction *B* is rather less.

The sulphur contents of the two fractions were kindly determined by Mr. M. W. Rees, who found





that fraction *A* contains four cysteic acid residues per molecule of molecular weight 2,900, and fraction *B* contains two per molecule of molecular weight 4,100. From these results it is possible to formulate a number of possible structures for the insulin sub-molecule. Thus, if we assume that it can be regarded as four parallel peptide chains, then only two structures are possible, as shown in the accompanying diagram, where the full lines represent the peptide chains and the broken lines the —S—S— bridges. The chains marked *G* have glycine terminal residues and those marked *P* phenylalanine terminal residues. It is assumed that the two glycyl chains have equal cysteic acid contents, which is probable from their similar properties. Other structures are possible if the chains cannot be regarded as parallel.

In order to carry further the investigation of the structure of these peptides, the products of the partial hydrolysis of their 2 : 4-dinitrophenyl-derivatives were studied. Using this method, it is possible to separate from a complex partial hydrolysate a relatively simple mixture of dinitrophenyl-peptides originating from the terminal peptides of the molecule. The isolation of a number of such peptides from an enzymic digest of insulin has already been reported by Woolley[2]. In the present work, acid hydrolysis has been used and the dinitrophenyl-peptides fractionated by partition chromatography on silica gel. The order of the amino-acids in them was determined by subsequent partial hydrolysis.

In a preliminary experiment with horse globin, the following peptides were isolated in a crystalline form and their structure determined: *H*1, 2 : 4-dinitrophenyl-valyl-leucine; *H*2, 2 : 4-dinitrophenyl-valyl-glutamyl-leucine; *H*3, the amide of *H*2.

This demonstrates that the six open peptide chains of horse globin[3] are not identical but consist of at least two different types, one with the terminal peptide valyl-leucine and one with the terminal peptide valyl-glutaminyl-leucine.

The method was then applied to the above fractions of oxidized insulin. From a partial hydrolysate of the dinitrophenyl-derivative of fraction *A* the following peptides were separated: *A*1, 2 : 4-dinitrophenyl-glycyl-isoleucine; *A*2, 2 : 4-dinitrophenyl-glycyl-isoleucyl-valine; *A*3, 2 : 4-dinitrophenyl-glycyl-isoleucyl-valyl-glutamic acid; *A*4, the peptide containing glutamic acid, leucine, serine and O-2 : 4-dinitrophenyl-tyrosine, which has been reported by Woolley[2]. Its structure has not yet been determined.

Fraction *A* thus consists of at least two separate chains with different terminal peptides. It is interesting to note that these chains, though not identical, are very similar in that they have no basic amino-acids, threonine or phenylalanine, are not easily separated from one another and have the same molecular weight and electrophoretic mobility.

Using fraction *B* the following peptides were detected: *B*1, 2 : 4-dinitrophenyl-phenylalanyl-valine; *B*2, 2 : 4-dinitrophenyl-phenylalanyl-valyl-aspartic acid; *B*3, 2 : 4-dinitrophenyl-phenylalanyl-valyl-aspartyl-glutamic acid; *B*4, ε-2 : 4-dinitrophenyl-lysyl-alanine; *B*5, threonyl-(ε-2 : 4-dinitrophenyl)-lysyl-alanine.

No evidence has yet been obtained of a second chain in this fraction.

The method of determining the structure of these peptides can be illustrated by considering the peptide *A*3. Using quantitative paper chromatography[4], it was shown that there was one molecule of isoleucine, valine and glutamic acid per molecule of 2 : 4-dinitrophenyl-glycine. While no great accuracy is claimed for this method as used here, it is sufficient to indicate without any doubt the number of residues present. On further partial hydrolysis of peptide *A*3, the peptides *A*1 and *A*2 and 2 : 4-dinitrophenyl-glycine were produced. From the composition of these peptides the order of the amino-acids could then be deduced, and it was confirmed by the identification of isoleucyl-valine in partial hydrolysate of peptide *A*2, by the method of Consden, Gordon and Martin[5].

In addition to peptide *A*4, Woolley has isolated from insulin a number of 2 : 4-dinitrophenyl-glycyl peptides in which threonine occurred not far from the terminal residue. We have not yet found evidence of these peptides in the present work in any of the main fractions of oxidized insulin; but it may be that they are not extracted under the procedure employed. It is possible, therefore, that there may be at least three different glycyl chains in insulin, though it is difficult to reconcile this with the present picture of the structure of insulin.

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"17-Ketosteroid II" Isolated from Urine; its Reaction with Hydrochloric Acid

In an earlier communication[1] we announced the isolation of a new 17-ketosteroid in the urine of a girl with adenoma of the adrenal cortex. This compound, which we designated "17-ketosteroid II", is converted in presence of HCl into a mixture of $C_{19}H_{27}OCl$ and dehydro-*iso*-androsterone. We have now studied this reaction in more detail.

In the first place we were able to prove that the compound $C_{19}H_{27}OCl$ is identical with the 3-chloro-Δ^5-androstenone-17 isolated by Butenandt and Dannenbaum[2] from human male urine. This compound can be synthesized by the method of Wallis and Fernholz[3] by the action of phosphorus pentachloride on dehydro-*iso*-androsterone. We purified the product thus obtained by means of chromatographic analysis. The melting point was 153·5–155·5° C. (corr.).

We then added 5 per cent aqueous hydrochloric acid to a solution of pure 17-ketosteroid II in ethanol; under these conditions the latter reacts immediately even at room temperature. The reaction mixture consists of about 80 per cent of $C_{19}H_{27}OCl$

with 20 per cent of dehydro-*iso*-androsterone. The chloroketone prepared from 17-ketosteroid II had m.p. 153·5–155·5° C. The mixed melting point with synthetic 3-chloro-Δ^5-androstenone-17 showed no depression.

In view of the great readiness with which 17-ketosteroid II reacts with hydrochloric acid to form 3-chloro-Δ^5-androstenone-17 (unlike dehydro-*iso*-androsterone), we assume that the 3-chloro-Δ^5-androstenone-17 found in urine has been formed from 17-ketosteroid II and *not* from dehydro-*iso*-androsterone (though 17-ketosteroid II occurs in normal urine in small quantities only). Although everywhere in the literature it is assumed that the chloroketone is formed from dehydro-*iso*-androsterone, Butenandt and co-workers[2] in their original publication did actually point to the possibility of a different precursor.

When 17-ketosteroid II is subjected to the action of hydrochloric acid at 100° C., the product is chiefly dehydro-*iso*-androsterone. When hydrochloric acid is allowed to act for 10 min. on 3-chloro-Δ^5-androstenone-17 (at 100°) the reaction mixture contains about 65 per cent of dehydro-*iso*-androsterone, the remainder being unchanged 3-chloro-Δ^5-androstenone-17. The identity of the dehydro-*iso*-androsterone was proved by means of the mixed melting point with an authentic sample of dehydro-*iso*-androsterone, 140–141° C. (corr.), and the mixed melting point of the corresponding acetates, 170–171° C. (corr.).

These facts lead us to the conclusion that the dehydro-*iso*-androsterone found in relatively large amounts in the urine of patients with carcinoma of the adrenal cortex must be regarded, to some extent at any rate, as an artefact produced by the action of hydrochloric acid on 17-ketosteroid II at the boiling point.

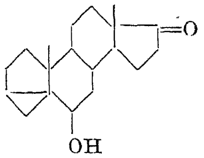
It also appears that the amount of dehydro-*iso*-androsterone thus formed is dependent on the duration of heating with hydrochloric acid. Boiling for 10 min. converts about 65 per cent of the 17-ketosteroid II to dehydro-*iso*-androsterone (see above). If, however, the urine is extracted with an organic solvent before hydrolysis, the 17-ketosteroid II present in the unconjugated form passes into the organic solvent. The result of such a method of extraction is that the amount of dehydro-*iso*-androsterone in the extract is much smaller than when the urine is boiled immediately with acid.

We think it worth while to direct attention to this in connexion with the estimation of dehydro-*iso*-androsterone in urine extracts for clinical purposes.

We have not yet succeeded in ascertaining whether 17-ketosteroid II can also exist in conjugated form in urine. In our previous communication[1] we stated that an acetate of this compound had been prepared (m.p. 109–111° C. (corr.)). Thus it contains an alcoholic hydroxyl group, so that it is by no means impossible that it may also be present in the esterified form in urine. The usual methods of hydrolysis will, however, convert these esters into dehydro-*iso*-androsterone.

Drs. Barton and Klyne (see following letter) kindly sent us a specimen of synthetic *i*-androsten-6-ol-17-one which proved to be identical with our 17-ketosteroid II; an identity that has already been considered in our previous paper. (We are glad to mention here that Dr. Beyerman, working at this Laboratory, suggested this identity for the first time, and we acknowledge with thanks this useful hint.) The identity of the compounds is established by mixed melting points and by identical adsorptive properties in chromatography.

The structure of 17-ketosteroid II is thus completely elucidated.



i-androstenolone

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Identification of "17-Ketosteroid II" as *i*-Androsten-6-ol-17-one

Dingemanse, Huis in 't Veld and Hartogh-Katz[1] recently described the isolation from human urine of a compound, "17-ketosteroid II", which they suggested was an androsten-3(α)-ol-17-one. Many of the reactions reported for this substance indicated that it might be *i*-androsten-6-ol-17-one, which has already been obtained by Butenandt and Suranyi[2] from the *p*-toluenesulphonate of dehydro-*iso*-androsterone. We have repeated the preparation of Butenandt and Suranyi, and have confirmed the properties recorded for this substance and for the corresponding diketone obtained on oxidation. The properties of "17-ketosteroid II" and *i*-androstenolone are compared in the accompanying table.

	17-Ketosteroid II	*i*-Androsten-6-ol-17-one
Melting point	140·5–141°	139–140°
$[\alpha]_D$ in alc.	+121°	+122°
Melting point of diketone obtained by oxidation	185°	184–185°

Our *i*-androstenolone showed no depression in melting point on admixture with "17-ketosteroid II" by Dr. Dingemanse, to whom we are most grateful for carrying out this comparison. The agreement in physical and chemical properties between the two compounds, together with this mixed melting point determination, proves that "17-ketosteroid II" and *i*-androsten-6-ol-17-one are identical.

The chloroketone, $C_{19}H_{27}OCl$, m.p. 151–152°, obtained by the Dutch workers by the action of hydrochloric acid on "17-ketosteroid II", must be 3(β)-chloroandrost-5-en-17-one, m.p. 155–157°, first isolated from urinary extracts by Butenandt and Dannenbaum[3].

So far as we are aware, this is the first report of the isolation of an *i*-steroid from urine or from any other natural source. Rosenheim[4] suggested that an *i*-steroid might be the precursor of the chloro-compound mentioned above. That *i*-steroids have not been detected previously in urine is doubtless due to the fact that the usual method of working up urine for its steroidal content (acid hydrolysis) must lead to the rearrangement of much or all of the *i*-steroids contained therein.

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Deodorization of Shark Liver Oil

Shark liver oil, which is one of the cheapest and most plentiful sources of vitamin A in Nature, has a highly disagreeable odour which is very much more pronounced than that of cod liver oil. On account of its unpalatability it does not easily find favour with the consumers. The deodorization of the oil has to be effected in such a manner that the highly susceptible vitamin A is retained intact. Among the various methods that we have tried to achieve this result are: (i) steam-'distillation' of the oil under normal and reduced pressure in which the malodorous substances pass over with the steam; (ii) agitation of the oil with fermenting milk and toddy; and (iii) selective hydrogenation of the oil in the presence of a nickel catalyst.

Steam-treated oils are fairly free from odour when freshly prepared, but revert in the course of a few days to their original character. Oils, deodorized by agitation with fermenting milk or toddy, have been found to remain bland for several months. The accompanying data with regard to the chemical constants, potency and stability of oils deodorized with fermenting milk and toddy as compared with those of the original oil show that very little change in these vital characteristics is involved in the process.

Chemical characteristics

	Milk-deodorized		Toddy-deodorized	
	Control	Treated	Control	Treated
Acid value	0·2	0·3	2·0	2·2
Saponification value	188	199	191	191
Iodine value	128	128	109	108

Vitamin A potency in international units per gram

Species of shark	Milk-deodorized		Toddy-deodorized	
	Control	Treated	Control	Treated
Stegostoma tigrinum	1,200	1,100	3,800	3,800
Pristis cuspidatus	5,900	5,900		
Hammerhead	37,000	36,900		
Bulk sample	11,200	11,100	9,600	9,600

Stability of the oil

Time, days	Peroxide value			
	Milk-deodorized		Toddy-deodorized	
	Control	Treated	Control	Treated
0	9·4	9·8	6·0	4·5
1	17·8	15·9		
2			21·4	23·6
3	47·8	46·4		
4	57·5	60·4	60·8	62·4
6	94·5	96·8	103·9	110·1
8	198·0	210·4		

Brocklesby[1] has indicated that hydrogenation of fish liver oils under carefully controlled conditions would eliminate the malodorous factors while the vitamin A itself may be kept unimpaired. Working with 0·1, 0·25, and 0·4 per cent concentrations of nickel catalysts prepared by the method of Adkins, Covert and Connor[2], we have obtained results which are quite promising. While 0·1 per cent of catalyst is not sufficient to effect complete deodorization (organoleptic test) within a temperature range of 100–180° C., 0·25 per cent of the catalyst effected fairly complete deodorization of the oil at 120° C. within 30–45 min. The percentage loss of vitamin A by this process is about 7, and stability studies have shown that the keeping quality of the oil has improved very considerably. 0·4 per cent of the catalyst caused increased destruction of the vitamin.

The accompanying table, giving results obtained with 0·25 per cent nickel catalyst at temperatures between 100° and 180° C. and reaction periods from 30 to 180 min., shows that the loss of vitamin increases progressively with increase in temperature and time of exposure.

	Time (min.)	Temperature (°C.)				
		100	120	140	160	180
Vitamin A*	30	97·1f†	84·0ff	93·0ff	89·0b	87·0
Vitamin A	60	92·9f	90·0b	85·5	74·8	71·2
Vitamin A	90	91·4ff	86·9b	76·4	68·0	56·9
Vitamin A	120	88·0b	80·2	70·7	56·7	43·0
Vitamin A	150	84·5b	74·3	64·3	48·0	31·3
Vitamin A	180	82·0b		57·0	42·1	20·2

*** Percentage of original content.**
† f = fishy; ff = faintly fishy; b = bland.

Further studies are in progress, and full details will be published as soon as they are completed. We are grateful to the University of Travancore for research scholarships awarded to two of us (P. K. M. and H. S.).

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Activities of Associating Solutes

There are comparatively few cases of binary mixtures in which the activity or fugacity of one component has been interpreted in terms of molecular properties. Well-known instances of such treatments are the Debye–Hückel theory of electrolytes and Hildebrand's theory of regular solutions. We have examined the case of a binary mixture where interaction between the two components is negligible, but where one of the components (the solute) has a tendency to form multiplets of any degree of complexity by means of association. Since interaction is assumed to be negligible, the non-ideality of the solute is attributable entirely to association, and each multiplet species (including the monomer) may be supposed to constitute an ideal sub-system. We propose to call mixtures of this type 'perfect associating mixtures'.

Since the solvent plays an entirely inactive part, a special case of this type is that of a gas, the ultimate molecules of which can associate to give multiplets. The second component (the solvent) is here replaced by the free space between the gaseous molecules. For sufficiently high temperatures and low pressures, each multiplet sub-species may be regarded as forming an ideal gas.

Examples of this type of system are certain solutions of polar solutes in non-polar solvents, and gaseous systems such as sulphur or iodine vapour at high temperatures.

The 'solute' will be considered as an equilibrium mixture of single molecules, doublets, triplets, etc. The total molarity (in terms of single molecules) of the solute will be denoted by n_s and the molarity of the various individual species (in terms of the appropriate multiplet molecules) by x_r. Here $r = 1$ for singlets, $r = 2$ for doublets, etc. If μ_r is the chemical potential of the r^{th} species, then

$$\mu_r = \mu_r{}^0 + RT \ln x_r. \qquad (1)$$

All species exist in equilibrium with one another, hence

$$r\mu_1 = \mu_r. \qquad (2)$$

If a definite volume of solution is considered (say 1 litre), x_r may be taken as the masses of the various species (expressed in moles). Hence if G_s is the Gibbs free energy of the solute as a whole

$$G_s = \sum_{r=1}^{\infty} x_r\mu_r = \mu_1 \sum_{r=1}^{\infty} rx_r. \qquad (3)$$

If μ_s is the chemical potential of the solute species as a whole

$$(\partial G_s/\partial n_s)_{T,P,n_l} = \mu_s, \qquad (4)$$

where n_l is the mass of the solvent in one litre of solution. For n_s, we can write

$$n_s = \sum_{r=1}^{\infty} rx_r. \qquad (5)$$

Equation (4) and subsequent equations derived from it would hold for solutions sufficiently dilute for n_l to be effectively constant, that is, for the volume of the solution to be approximately equal to the volume of the solvent. Thus, from equations (3), (4) and (5),

$$\mu_s = (\partial G_s/\partial \sum_r rx_r)_{T,P,n_l} = \mu_1. \qquad (6)$$

Writing the last equation fully,

$$\mu_s{}^0 + RT \ln a_s = \mu_1{}^0 + RT \ln x_1, \qquad (7)$$

where a_s is the activity (or the fugacity) of the 'solute' species as a whole. Since at infinite dilution n_s tends to x_1 and also to a_s, the standard chemical potentials $\mu_s{}^0$ and $\mu_1{}^0$ must be identical and hence

$$x_1 = a_s. \qquad (8)$$

For such mixtures, therefore, the activity of the solute (in molarity units) is identical with the molarity of the singlet species. For the conditions when this is valid (that is, volume of solution approximately equals volume of solvent), it is easily deduced that it is also true that the activity of the solute (in molality units) equals the molality of the singlet species. For the corresponding case for associating gases a similar treatment yields the result that the fugacity of the gas equals the partial pressure of the singlet species.

The application of this new relationship to certain gaseous and liquid systems will be discussed at greater length elsewhere.

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Autoradiography of the Thyroid Gland

AUTORADIOGRAPHY of the thyroid gland has been carried out by various methods: (1) mounting sections of tissues containing radioactive iodine on glass slides, applying these slides with pressure against the emulsion of a photographic plate[1]; (2) melting photographic emulsion and pouring it over a section[2]; (3) mounting the sections directly on the photographic emulsion[3]; and (4) a modification of (2), by removing from its base Ilford half-tone thin film, dry-stripping emulsion and mounting it on top of the slide-bearing sections[4].

The first method, although the stained slide and the developed photographic plate may be examined in conjunction, does not permit accurate localization. In the second method a heavy blackening of the emulsion may obscure the section, even though stained. Pelc[4] was unable to stain the section through the emulsion in the fourth method. The third is simple to use, and the section may be stained with ease, and precise histological localization of the blackening of the emulsion obtained. It is well suited for serial sections used in the present work.

In the present experiment, 25 micro-curies of radioactive iodine (I^{131}) was injected in the form of sodium iodide intraperitoneally into a normal adult male mouse. After two hours, the animal was killed with chloroform. The thyroid lobes were removed and fixed in aqueous formalin. Water-soluble iodine compounds are dissolved by aqueous fixatives and may either be removed from the tissue or translated. To obviate this, Pelc[4] fixed thyroid tissue in alcohol. However, it has been shown[5] that autoradiographs obtained by fixing thyroid tissue in aqueous fixatives do not differ from those obtained by freeze-drying. This indicates[5] that iodine is probably rapidly bound to protein in the gland and ceases to become diffusable. Aqueous fixatives are therefore admissible for thyroid autoradiographs.

Following fixation, the thyroid lobes were embedded in wax in the usual way, and serial sections of the whole gland were cut at a thickness of 7 μ. The ribbons bearing the sections were floated on warm water in a dark room and mounted directly on to the emulsion of Ilford thin-film high-resolution plates (4½ cm. × 6 cm.). All sections were mounted in series and dried overnight. Then the wax was dissolved off (paraffin wax absorbs some of the radiation). The plates were re-dried and kept in a light-tight box for six days, then developed by usual methods. The sections remained in place and were later stained with neutral red. (Hæmatoxylin and eosin) tends to obscure the blackened emulsion. Localization of radioactive iodine in the colloid of the follicles was clearly demonstrated by this method. It is known[6] that within half an hour of administration radioactive iodine has begun to accumulate in the thyroid,

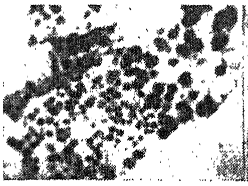

Fig. 1

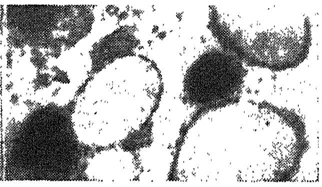

Fig. 2

Fig. 1. Low-power view (× 40) of autoradiograph of mouse thyroid. Small and medium-sized follicles are blackened; larger follicles are not

Fig. 2. High-power view (× 270) of part of autoradiograph of mouse thyroid. Two large follicles can be seen with practically no blackening of the colloid. In the top right-hand corner can be seen a further large follicle in which the follicular cells are taller than in the other large follicles in the section. The colloid has blackened slightly more than in the others. Two small follicles can be seen which have given an intense blackening

and in the present work (two hours after injection) most of the follicles had shown some signs of concentrating the iodine.

The smallest follicles appeared to have concentrated the radioactive iodine more rapidly than the larger follicles. (Hamilton[7] made a similar observation on the thyroids of two hypothyroid children.) In some very large follicles no blackening in the region of the colloid had occurred. In these the process of concentrating iodine was probably at a very low level or had ceased.

It was found that no part of the thyroid was more active than any other part in concentrating the radioactive iodine. Follicles of different sizes were scattered indiscriminately through different parts of the gland. All the small follicles with cuboidal or near-cuboidal cells had radioiodine in their colloid, and all the large ones showed varying amounts according to the degree of flattening of the epithelium. In some large follicles with moderately flattened cells—although the colloid showed no reaction—there was a rim of blackened emulsion surrounding the colloid and coinciding with the epithelium. It is of interest that blood vessels in the preparations, which must have been carrying radioactive iodine, showed no signs of having blackened the emulsion, presumably because the former is present in too low a concentration. Leblond[8] has shown that, 15 hr. after administration, radioactive iodine is present in greater amounts in acidophilic than basophilic thyroid follicles (Mallory's trichrome stain); he believes the difference is due not to the differing powers of storing radioiodine but to variation in time of retention. The present experiment (2 hr. after administration) suggests that iodine is still being absorbed and that the follicles store it at various rates, and that the more flattened the epithelium the slower the rate of storage (a not unexpected finding). The staining method used did not permit a satisfactory differentiation between acidophilic and basophilic follicles.

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Effect of Phosphorus on the Hydrolysis and Absorption of Sucrose by Plant Cells

SOME years ago I demonstrated[1] that excised barley leaves from phosphorus-deficient plants showed considerably increased respiration intensities if their cut ends were immersed in neutral sodium phosphate solution instead of water. Feeding similar leaves with sucrose solution also increased the respiration-rates; but the increase was much smaller than when phosphorus was administered. The sucrose effect was less apparent when phosphorus deficiency was more acute. Still higher rates of respiration were obtained if the phosphorus-starved leaves were supplied with both sucrose and phosphate together.

Later, I showed[2,3] that when slices from storage organs are floated in sucrose solution, the latter is never absorbed by the plant tissues as such: but it is always first inverted in the medium and the products of inversion are afterwards absorbed. I have recently noticed the same phenomenon when the cut ends of plant leaves are dipped in sucrose solution, the sucrose being hydrolysed before its absorption. Feeding experiments on normal and phosphorus-starved barley plants are now in progress, and the results indicate that when excised phosphorus-starved leaves are dipped in sucrose solution, the rate of sucrose inversion in the medium and also the rate of uptake of the hydrolysis products are remarkably reduced. Feeding with neutral phosphate and sucrose together restores the normal hydrolytic and absorptive capacities to these plants.

This is interesting because it shows that in the early respiration experiments, the sucrose of the culture medium never entered the cells as such; and sucrose could not be synthesized inside the phosphorus-deficient cells because of the lack of phosphorus[4,5,6,7]. It is also evident that the respiratory substrate may be directly produced from sucrose hydrolysis[8,9,10]; but the latter process is extremely affected by phosphorus, being very much reduced under conditions of phosphorus starvation. In this connexion, it may be mentioned that Lyon[11] and Richards[12] advocated the view that phosphate is normally involved in the respiratory breakdown of sugar in plant leaves.

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Crystallization of Whale Myoglobin

ALTHOUGH the spectroscopic differences between blood and muscle hæmoglobin were first observed by Mörner[1] in 1897, it was not until 1932 that Theorell[2] succeeded in crystallizing myoglobin from horse-heart muscle.

The myoglobins from several species of animals have since been prepared by various workers[3,4,5,6], and recently Theorell[7] described the preparation of crystalline human myoglobin from heart muscle and from the urine of cases of myoglobinuria.

Whale meat is of a very dark colour, and since it is often available, it was of interest to establish whether it is suitable for large-scale preparations of crystalline myoglobin. Two methods of preparation are described below, and in each case good yields of crystalline myoglobin are obtained. For the production of larger crystals suitable for X-ray crystallography, the final crystallization must be carried out in phosphate solutions.

(*a*) *Crystallization of CO-myoglobin* (J. K.). The whale meat (about 4 kgm.) was roughly dissected to remove any neurovascular bundles while it was still frozen solid, cut into small cubes which were inspected for any remaining blood vessels and minced. The mince was extracted with an equal weight of water overnight in a cool place. The fluids obtained first by draining and then by pressing the mince in a hydraulic press were sometimes found to be very greasy and had to be centrifuged to remove the fat as a solid layer from the surface of the fluid. The dark red myoglobin solution was neutralized with 10 per cent sodium hydroxide to pH 7·3, and the bulky precipitate formed was removed by filtration through paper pulp. (For all subsequent filtrations a Buchner funnel with hardened paper was used.) The filtrate was brought up to 50 per cent and then to 70 per cent saturation with ammonium sulphate, keeping the pH at 7·3, and the resulting precipitates were in each case filtered off and discarded. The pigment which had by now oxidized to metmyoglobin was converted to CO-myoglobin (using a minimal amount of $Na_2S_2O_4$ as reducing agent) as this compound is more resistant to denaturation than metmyoglobin. The pigment was examined spectroscopically after each of the following manipulations, and carbon monoxide was passed through the solution when necessary. The myoglobin was next brought up to 80 per cent saturation with ammonium sulphate, rapidly filtered and the precipitate was discarded. The filtrate was dialysed against neutralized saturated ammonium sulphate until the myoglobin was completely precipitated, when it was filtered off, dissolved in distilled water and reprecipitated by dialysis.

The myoglobin was then fractionated by dialysis against neutralized ammonium sulphate at 60, 70 and 75 per cent saturation respectively, all precipitates being discarded. The filtered CO-myoglobin was finally dialysed against neutralized 80 per cent saturated ammonium sulphate until it was just faintly turbid, when it was transferred to a closed glass vessel and placed in the cold to crystallize. Whale CO-myoglobin prepared by this method forms needle- or lens-shaped crystals arranged singly, in sheaves, or in rosettes. Flat plate-like crystals with parallel sides have also been observed in the course of one preparation.

(*b*) *Preparation of Metmyoglobin crystals* (K. S.). This method was based on the known differences of solubility between the hæmoglobin and myoglobin of any particular species of animal in concentrated phosphate buffer, as described by Morgan[8] and Theorell[7].

A mixture of 491 gm. $NaH_2PO_4.2H_2O$ and 546 gm. K_2HPO_4 was added to 2,100 ml. of an approximately 1 per cent solution of CO-myoglobin previously fractionated with ammonium sulphate and dialysed against distilled water according to Theorell[7]. The resulting precipitate was filtered off and the filtrate saturated with the above phosphate mixture added in small amounts. The pigment having spontaneously oxidized during these manipulations, the precipitated metmyoglobin was filtered off on a Buchner funnel and the phosphate fractionation was repeated three times. After the second fractionation the α-band of the carbon monoxide compound as measured by the Hartridge reversion spectroscope remained constant at 5793 A. Small quantities of a mixture of 9·5 parts K_2HPO_4 and 17·0 parts $NaH_2PO_4.2H_2O$ were added with mechanical stirring until a small permanent precipitate appeared. This was filtered off on a hardened filter on a Buchner funnel. On standing at room temperature for 2–12 hours the metmyoglobin crystallized from the filtrate in dark-brown crystals belonging to the orthorhombic system[9].

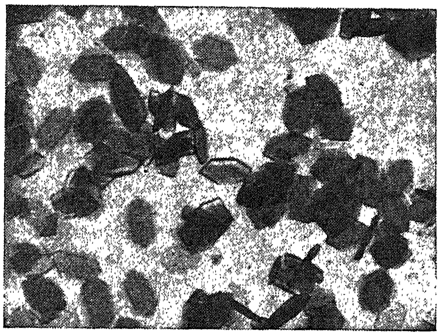

Fig. 1. Phosphate buffer. pH 5·7. 3·5 M. × 89

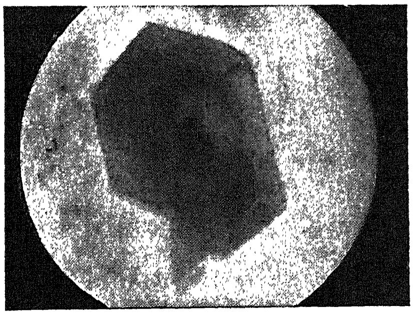

Fig. 2. Phosphate buffer. pH 5·7. 3·4 M. Large crystal. × 34

We wish to thank Prof. A. C. Chibnall for his interest in this work and Dr. J. G. Sharp of the Low Temperature Research Station for the whale meat. Thanks are also due to the Medical Research Council (J. K.) and to the Stiftung für Stipendien auf dem Gebiete der Chemie (K. S.) for personal grants.

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K. SCHMID

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Aug. 3.

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THE COLONIAL MICROBIOLOGICAL RESEARCH INSTITUTE, TRINIDAD

THE ceremony of the opening of the Colonial Microbiological Research Institute in Port-of-Spain, Trinidad, British West Indies, was performed on July 5 by Lord Hankey, in the presence of a distinguished gathering including the Governor of Trinidad and Tobago, Sir John Shaw; the chairman of the Standing Closer Relations Committee, Sir Hubert Rance; Prof. J. L. Simonsen, director of research of the Colonial Products Research Council; the principal of the University College, Jamaica, Dr. Taylor; the acting principal of the Imperial College of Tropical Agriculture, Trinidad, Dr. Shepherd; and delegates from other Caribbean countries, from the United States, Mexico, Venezuela, Honduras, etc.

Introducing Lord Hankey, the Governor expressed his satisfaction at the presence of Lord Hankey and of so many distinguished delegates; on behalf of the peoples of Trinidad and Tobago he thanked Lord Hankey for having chosen Trinidad for this undertaking, which he understood was to serve as a research centre for theoretical and applied microbiology for the benefit of the Colonial Empire as a whole.

In a message read by Lord Hankey, Sir Robert Robinson, president of the Royal Society, conveyed the following greetings from the Royal Society: "It is impossible to visit any tropical or sub-tropical country without becoming more and more insistently aware of the importance of general microbiological research. In the field of the pathogenic organisms this need has long been recognized, and to some extent satisfied, but the importance of the wider aspect has not been equally well understood. Entirely inadequate provision has been made for such investigations whether from the point of view of pure biology, biochemistry, hygiene and medicine, or of industry. When Dr. Simonsen and I visited Trinidad in 1944, the need for extended microbiological research was obvious to us as a special instance of the general thesis. It was clear, too, that the facilities that could be made available, the side-contacts, and the general conditions were favourable for the development contemplated. Not only the health of the community in the physical sense, but also in the economic sphere, was seen to be tied up with microbiology in its wider implications.

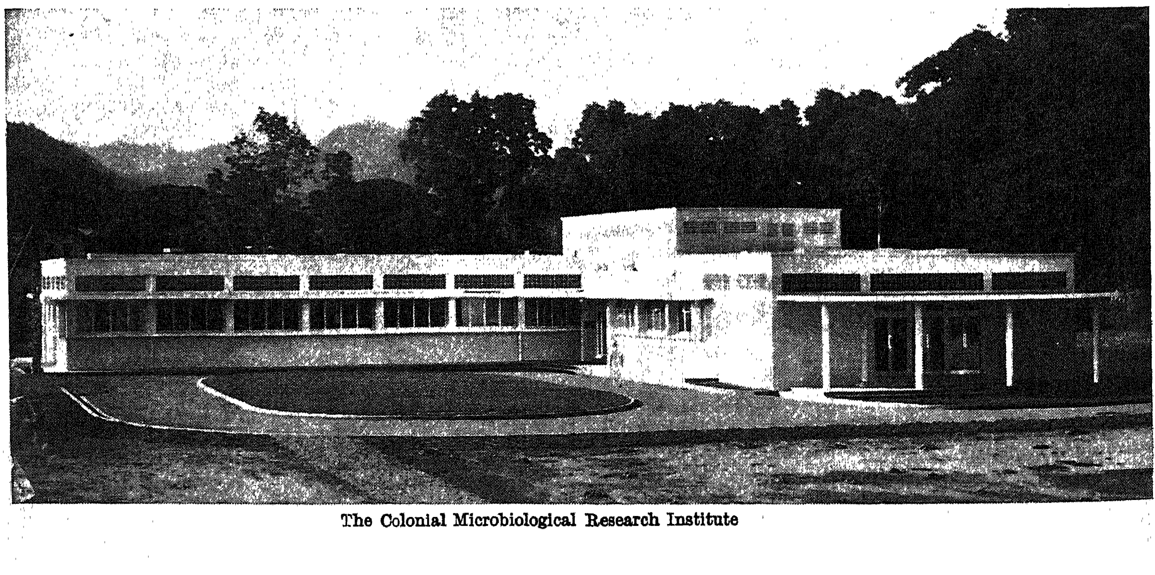
"On return to England, we found as a most fortunate and compelling circumstance that it might be possible to persuade Dr. Thaysen to undertake the organisation and first Directorship of a projected Institute for Microbiological Research. That was decisive and further steps taken are well known to you all. It is with real satisfaction that I send this message of felicitation to an Institute which I am sure is destined, not only to play an important part in the development of Trinidad and the Caribbean, but also to give an example to the rest of the world. It will surely make a significant contribution to science and we hope also to human happiness and prosperity."

In his address, Lord Hankey gave a brief review of British Colonial policy and organisation in scientific research and development in which the Institute is a link, and he sketched the history of the Institute's conception.

Amplifying Sir Robert Robinson's remarks, Lord Hankey asked: "Our aspirations! What are they? I dare not pitch them too high, or we may disappoint you. I must not pitch them too low, because, on a long view, they have no ceiling any more than has the blue firmament above Trinidad. But our first aspiration must be pure research; that wresting from Nature of her secrets; that process of getting to the bottom of things from which great results follow. Think of the pioneer work of Newton, of Faraday, of Herschel, of Pasteur, of Rutherford, and hundreds of others from which have been produced the marvels of modern science. Apply that thought to microbiology and you get some idea of our fundamental aims and ambitions for the microbiological institute.

"But we shall not limit ourselves to pure science. We shall continue, as hitherto, to exploit to the utmost the application of research for the benefit of mankind.

"It will interest you to know that, as the result of a recommendation by the British Commonwealth



The Colonial Microbiological Research Institute

Scientific Official Conference in 1946, the Microbiological Institute in Trinidad has become an official centre for the British Commonwealth for Culture Collections of Micro-organisms, where types of micro-organisms will be carefully preserved. That is essential if full advantage is to be taken of research in microbiology.

"I could give many further illustrations of what we have accomplished in our early, pioneer years, but I have said enough to give some impression of the kind of benefits we hope to derive from the pursuit of microbiology in this Institute; but in saying that, I must again emphasize that pure research must come first and that any deviation from that aim in pursuit of quick results might be calamitous."

Lord Hankey then went on to ask why Trinidad had been chosen for this important work. To begin with, he said, it was essential that the work undertaken in a new centre being intended mainly for the good of the tropical Empire should be undertaken within the tropics. "We were greatly influenced also," he continued, "by previous experience of the danger of placing such an Institute in isolation. Apart from the Caribbean Research Council, Trinidad already houses the famous Imperial College of Tropical Agriculture with its valuable library, and it seemed to us that to place the Institute within easy reach of the College should be of material benefit to both, owing to the close association with other scientists that each would enjoy. In this connexion it is very interesting that Dr. L. F. Wiggins, who has been prominent in assisting Sir Norman Haworth on the important work at Birmingham University on starch and sugar to which I have already referred, has recently been appointed by the West Indies Sugar Association as head of the new Department of Sugar Technology at the College. This should give a splendid start to the development of this branch of the College which was another of the suggestions made by Sir Robert Robinson and Prof. Simonsen.

"We had in mind also the opportunities that the Institute might afford for the important study of soil microbiology, and we did not overlook the prospects of invaluable contacts with the scientists of the Trinidad Government and of the refineries, oil companies and other industrial concerns in the island, as well as its associations, societies, and institutes. In particular we look forward to a close link with the University College of the West Indies.

"But to these more or less official reasons for the selection of Trinidad I would add one more, which makes a special appeal to me, as a layman, and is expressed in language more eloquent and more imaginative than I can command in the following passage from Charles Kingsley's 'At Last', chapter 14, entitled 'The High Woods', which was inspired by his observation of the Trinidad forest, while visiting the island in the last century: 'The eye is not filled with seeing, or the ear with hearing; and never would be, did you roam these forests for a hundred years. How many years would you need merely to examine and discriminate the different species? And when you have done that, how many more to learn their virtues, properties, uses? By what miracle they are compacted out of light, air and water, each after its kind? How, again, these kinds begin to be and what they were like at first? Whether these crowded, struggling, competing shapes are stable or variable? Whether or not they are varying still? Whether even now, as we sit here, the Great God may not be creating, slowly, but surely, new forms of beauty around us.' To sum up—in the words of Lucretius—'*Felix qui potuit rerum cognoscere causas*' (Happy is he who can know the causes of things. Lucretius, 'De Rerum Naturæ')."

After luncheon the company proceeded to the grounds of the Institute and here Lord Hankey unveiled a plaque with the name of the Institute engraved upon it, and opened the main entrance door with a key made of West Indian gold and presented to him by the architects who designed the buildings, Messrs. Watkins and Partners, of Bristol and Port of Spain. At the suggestion of the Director, Lord Hankey graciously consented to have his name associated with the culture collection maintained at the Institute as a link with Commonwealth culture collections of micro-organisms, and agreed that this culture collection in future should be known as "The Hankey Culture Collection" instead of the "Colonial Culture Collection".

A description of the Institute has already been given in *Nature* of July 3, p. 14.

Following the official opening, two morning sessions on July 6 and 7 were held in the library of the Institute. At the first of these Lord Hankey took the chair, and at the second, Prof. J. L. Simonsen. Many delegates and others read papers at these meetings, which were largely attended.

It is hoped, in due course, to compile an abbreviated account of the subjects dealt with in these discussions, and to issue them as a commemorative publication.

J. L. SIMONSEN

SOUND TRANSMISSION AND NOISE

A VERY successful symposium on sound transmission and noise was held during July 14–16 by the Acoustics Group of the Physical Society, with the kind co-operation of the Royal Institute of British Architects, in the Jarvis Hall of the latter, at Portland Place, London. The proceedings were opened by Mr. H. L. Kirke, chairman of the Group, and overseas visitors were present from the United States, France, Denmark, Holland, Sweden, Switzerland, Italy and Germany.

The opening session was devoted to problems of sound transmission. In the first paper, Dr. L. L. Beranek, of the Massachusetts Institute of Technology, described investigations he has been carrying out into the determination of the attenuation of single and multiple panels. To avoid the expense of the usual two-room method, he has developed a model test using panels 18 in. square giving results which agree well with full-scale tests and with theory. He has applied the theory to seven kinds of structures and has deduced charts which enable the attenuation, for partitions of known dimensions, mass and porosity, to be readily determined. Similar work in Great Britain at the National Physical Laboratory was described by Dr. G. H. Aston. He has not found any marked effect with size in the attenuation of glass windows, but there is an upper limit to the mass which it is worth while using set at 24 oz. glass by the compliance of the framing. With double windows there is an increase in attenuation with spacing even up to 7 in. at low frequencies, but 4 in. is sufficient at high frequencies. His work on plaster walls has shown a curious effect with time, the attenuation showing a cyclical variation during the first few days. He finds that strip metal ties for cavity walls provide much more coupling than wire 'butterfly' ties, especially at low frequencies.

Dr. Theodore Vogel, of the Centre National de la Recherche Scientifique, Marseilles, could not attend, but his paper on the transmission of sound by elastic panels was read by Prof. Canac. It gives a mathematical treatment of the vibration of a thin plate to waves of normal incidence using Lagrange normal co-ordinates. The resulting expression contains the simple piston result of Davis together with a term depending on the panel dimensions. Extensions of the theory to cases of double partitions and panels covered with porous coatings are given, and all the formulæ have been checked experimentally.

Mr. W. A. Allen, of the Building Research Station, Garston, Herts, traced the development of the party wall. The modern standard is an attenuation of 55 db., and no practical single-leaf construction has been found to give this. Two-leaf constructions of 3 in. and 4 in. thickness can reach the required standard; but it is necessary to give special attention to leakage paths, especially windows and chimneys.

Dr. Furrer, of the G.P.O., Berne, gave very interesting and useful information on the elastic properties of various materials in sheet or quilt form suitable for making floating floors to reduce impact sound. His results illustrate the good elastic properties of glass silk.

A joint committee representing Britain, Denmark and Holland has been formulating proposals for measuring insulation to air-borne and structure-borne sound, and these were put forward on behalf of the committee by Dr. Ingerslev, of Denmark. Air-borne insulation results should be corrected to a reverberation time of 0·5 sec. to match ordinary rooms. Impact sound insulation should be determined with closely specified apparatus, and subjective measurement is important. Analysers of $\frac{1}{3}$ or $\frac{1}{2}$ octave bandwidth are used and the results are summed. Dr. Aston described work at the National Physical Laboratory on the insulation of wood joist floors. Using a raft and pugging, he has attained 55 db. insulation to air-borne sound and 20 db. more than an ordinary floor to impact sound.

Measurements of impact sound at London, Copenhagen and Delft were described by Dr. Kosten. Discrepancies were removed by using the same tapping instrument, a 'Rawlplug' hammer.

A record of team-work by the National Physical Laboratory and Building Research Station staffs on the insulation of discontinuous structures was given by Mr. W. A. Allen. Mr. H. R. Humphreys described further work at the Building Research Station on floating floors, giving details of different constructions and results obtained in the laboratory and actual buildings.

The final paper for this session was read for Mr. Kipfer by Mr. P. Germain and described the method developed at the University of Brussels for measuring footsteps noises. In the discussion on the first day's papers, Prof. A. Giacomini made a plea for agreement on acoustical definitions and authors replied to questions, mainly on attenuation in structures. Cases of linear and geometric attenuation in decibels with distance were quoted.

The morning of the second day was devoted to papers of architectural interest, under the chairmanship of Mr. Hope Bagenal. Mr. W. A. Allen presented the results of a survey of domestic noise giving the proportion of people suffering in one way or another from noise. Banging doors appear to cause most trouble, but very careful framing of questions is necessary to obtain reliable information. He emphasized the strain due to self-imposed constraint on one's activities.

A large-scale investigation on a number of experimental flats at Rotterdam was described by Dr. Kosten. Several kinds of walls, ceilings and floors have been tried, together with resiliently isolated piping and sanitary installations. Dr. Kosten continued with a critical examination of similarity or scale tests, and his analysis shows the method to be very useful in determining sound insulation.

A short paper by Dr. J. L. Burn, medical officer of health, Salford, on noise in schools was read by Dr. King. The problem is outlined and results of noise measurements in typical schools are given.

Dr. Grunenwaldt's paper, also read by Mr. Germain, gives noise surveys of the ships *Prinz Albert* and *König Albert* and compares them with earlier surveys by Robinson. The engine rooms have been treated and show 102–106 phons.

Noise on board aircraft as it affects telephony was discussed by Mr. P. Chavasse, chief engineer of the Acoustic Department, Centre National d'Études Télécommunications, Paris. His paper gives general directions for improving telephonic communication on board and includes an analysis of the origin and nature of the various noises.

A complementary paper to Mr. Allen's on domestic noise was read by Mr. P. H. Parkin, also of the Building Research Station, on insulation of flats from sound. The complete programme outlined begins, logically, with a social survey, discusses methods of measurement of attenuation of air-borne and structure-borne sound and gives test results on typical constructions.

Prof. Canac's paper, which he gave in French, on the acoustics of ancient Greek and Roman theatres, came as a welcome change to many present. His studies of the theatres of Orange and Vaison have shown the importance of the various structural features and point out lessons. The relation between the various absorption coefficients was discussed by M. Grunenwaldt. His paper gives the experimental basis for a relation between the Taylor and Sabine coefficients.

In the ensuing discussion, Dr. Beranek referred to the calculation of loudness from analyses and Dr. King outlined the method, originally due to Dr. B. G. Gates, which he uses. Dr. Mintz, U.S.A. Navy Department, suggested an accelerometer instead of velocity meter for similarity tests.

The morning of the third day was devoted to noise measurement, the chairman being Mr. W. West. The opening paper by Mr. R. S. Dadson, of the National Physical Laboratory, gives a survey of the problem of noise measurement, outlining the difficulties in making measurements in the field in terms of the fundamental unit of equivalent loudness. He compares the performance of objective and subjective meters particularly on motor-car exhaust noise, and points out the necessity for general agreement on equal loudness contours and the summation of analyses.

Dr. A. J. King's paper on a portable objective noise meter refers briefly to the errors of sound-level meters on complex noises and describes a much simplified peak/R.M.S. meter. Readings on typical noises are compared with subjective and sound-level meters showing less errors than the latter.

A mains-driven meter operating on the same principle was described by Mr. D. A. Nutt. This instrument conforms to the standards of the Acoustical Society of America but also incorporates peak/R.M.S. measurement. It is intended for routine factory use.

M. P. Baron gave his paper on objective noise measurement in French. He feels that objective meter readings and summations from analyses are unreliable and should be confined to comparing similar noises.

In his paper, Mr. Maurice, of the B.B.C., deals with a different aspect of noise, namely, interference with broadcast reception. He has correlated subjective assessment of interference with readings by various meters and finds a weighted energy meter gives the closest correlation.

The paper by Lord Halsbury describing a rapid wave analyser was read in his absence by Mr. D. G. Jaquess. The instrument is a heterodyne analyser covering 0–30 kc./s. with provision for sweeps of $\frac{1}{6}$ to $\frac{1}{3}$ sec. and maximum resolution. It also permits more detailed examination of a 2 kc./s. band.

In his paper on the reduction of noise in aircraft, Mr. N. Fleming, of the National Physical Laboratory, deals with the contributions from the engine, propellers, aerodynamic flow and auxiliaries. He has studied octave frequency bands in each case and he shows the effects of power, tip speed and air velocity.

M. P. Chavasse read his paper describing an apparatus to produce complex sounds and artificial voices for acoustic tests in French. It is based on valve noise with suitable modulation to simulate the voice. Results obtained with it agree well with those for the natural voice.

In the discussion after this session, Dr. Beranek described recent work in the United States tending to confirm the level high-intensity equal loudness contours. He questioned the differences between pressure and field sensitivities of the ear, hinting at an obscure effect. He also asked for terminological agreement on 'random' and 'white' noise. Mr. Fleming objected to the indiscriminate use of phons for decibels, and Dr. Furrer asked about the calculation of loudness from analyses.

For the final session Mr. Kirke was again in the chair, and papers covered a wide range of applied acoustics. First, Dr. L. Cremer, who had only just arrived from Munich, read his paper on sound insulation at oblique incidence. Consideration of the travelling waves along a panel with a sound at oblique incidence suggested to him that grooves in the panel would improve attenuation. His paper gives the theory and experimental confirmation.

Dr. Kosten had had to return to Holland, so the joint paper on sound absorption in layers of material was read by J. van den Eijk. The paper gives the theoretical performance of such layers and includes experimental confirmation.

In his paper on noise in air ducts, Dr. Grunenwaldt gives the results of noise measurements on several ventilation systems with various air velocities and duct lengths. These data enable him to design duct systems for given room noise conditions.

The paper by Dr. A. Schoch, of Göttingen, on absorption by gradual transition gives the theory for successive layers of material of increasing density, leading up to the modern wedge construction. He takes as an example a linear wedge structure and gives curves for its performance.

Mr. C. A. Mason described the development of quiet chokes for use with fluorescent lamps. His paper examines the essential causes of the noise—magnetostriction and bad joints—and shows the stages followed in their reduction. He also considers the noise of a number of chokes.

In his paper on the elastic properties of rubber, Dr. E. Meyer, of the University of Göttingen, describes an elegant method using a sample in a resonant column of liquid. This gives bulk modulus and dissipation, while Young's modulus is given by longitudinal resonance or travelling waves. The frequency range covered is 10 c./s. to 20 kc./s. Effects of temperature and load are also discussed.

Mr. C. H. Bradbury's paper discusses the noise of machines, especially Diesel engines. He gives noise spectra and considers the pitched and unpitched components. He emphasizes the shock excitation of damped systems and uses a loud speaker to show up resonances. He also considers the effect of background noise.

Owing to the unavoidable absence of Prof. P. Bruel, Dr. V. L. Jordan, Mr. E. N. Storr and Mr. R. S. Hogben, their papers were not read but will be published in the *Proceedings*.

There were many contributors to the closing discussion. Among them, Mr. Fleming quoted work at the National Physical Laboratory disagreeing with Dr. Cremer on grooves and he also suggested that 'frequency of troubling' should be included in Mr. Allen's questionnaire. Mr. Mason asked about the critical frequency between dynamic-static properties of rubber, and Dr. Meyer gave it as 1 or 2 c./s. Dr. King said he was investigating the matter and thought it would be nearer 0·1 c./s. M. Brillouin gave a humorous contribution suggesting that the phon is insufficiently defined for practical purposes, but Mr. Fleming, chairman of the British Standards Institution Committee on Noise Measurement, gave a convincing reply.

A. J. KING

MIDDLE EAST OIL

THE name of that distinguished American geologist and statistician, Dr. Everette de Golyer, has been proverbial in international oil technology for many years past. He has an almost uncanny flair for predicting correctly the trend of events in the petroleum world, and his forecasts on developments in those countries comprising the Middle East are no exception. So long ago as 1925 the writer remembers de Golyer saying that "he expected from Persia a continued increase in production, as handling and marketing facilities are increased, so long as the fields may last". Nearly twenty years later, when leader of the United States Petroleum Commission to the Middle East, he stated that "the centre of gravity of world oil production is shifting from the Gulf – Caribbean area to the Middle East and is likely to continue to shift until it is firmly established in that area". That this has actually happened is probably not generally appreciated: the economic, technical and political implications of the fact have yet to be assimilated by the public, quite apart from the industry itself. To this end an up-to-date, straightforward survey of the position is essential to its understanding, and the *Petroleum Times* has rendered signal service by publication of its "Review of Middle East Oil" (London, June 1948, 7*s*. 6*d*.).

This review is not a mere compilation. It presents 'eye-witness' accounts of the shape of things concerning oil in Iran, Iraq, Bahrein, Saudi Arabia and Kuwait as they are to-day. It is based fundamentally on a two-months tour of the oilfields at the close of 1947 undertaken by Dr. C. T. Barber, joint editor of the *Petroleum Times*, with reinforcements by Dr. G. M. Lees, chief geologist of the Anglo-Iranian Oil Company, Ltd., Max Weston Thornburg, war-time petroleum adviser to the U.S. State Department, Christopher Holme, well-known writer and broadcaster on Middle East affairs, and T. D. Weatherhead, technical manager, Hunting Aerosurveys, Ltd.

Consider first some vital statistics that emerge from this survey. In 1936 the proved oil reserves of the world were proportioned as follows: U.S.A., 48·1 per cent; Middle East, 21·1 per cent; U.S.S.R., 12·9 per cent; Caribbean and Mexico, 9·7 per cent; and the rest, 8·2 per cent. In 1944 the figures were 33·9, 42·3, 9·0, 10·0 and 4·8 per cent, respectively. Thus in eight years Middle East reserves were doubled. Next are the production figures. In 1936, the U.S.A. produced 60·7 per cent, Middle East 5·4 per cent, U.S.S.R. 11·9 per cent, Caribbean and Mexico 13·2 per cent, and the rest 8·8 per cent of the world total output of crude oil. In 1947 the figures were 63·6, 9·8, 5·5, 17·3 and 3·8 per cent, respectively. Again, in the intervening years, Middle East nearly doubled its production. Further, with 42 per cent of world reserves, the Middle East produces 10 per cent of world output and in 1947 was drawing on reserves at the rate of 1·14 per cent per annum. By contrast, the United States with 33·9 per cent reserves produce 64 per cent of world output and are drawing on reserves at the rate of 9·25 per cent per annum. Still more striking, as Dr. Barber shows, is the fact that in 1947 Middle East production of 306 m. barrels was obtained from 223 wells, an average of 1·37 m. barrels per well, whereas the United States production of 1,985 m. barrels was obtained from more than 425,000 wells, an average of 4,660 barrels per well.

It is commonly believed that the present drastic rationing of petrol in Great Britain is a post-war legacy and a dollar-saving necessity. Why, it is asked, if we control such enormous oil production in the Middle East, is petrol so short in Britain, and why import from the Americas? The fact is that dollar-saving is not the whole story by any means. All over the world people are using more and more oil. In 1947 the American demand was 73·1 per cent more than in 1938; the demand in Great Britain was 45·3 per cent more; the British Commonwealth as a whole consumed over 100 per cent more, while other countries increased their demand by 17·2 per cent. In other words, the world oil demand has increased more than 50 per cent in the nine-year period, accounted for largely by heavily increased requirements of the United States for military, agricultural, domestic and transport purposes. C. J. Bauer has estimated that world demand in 1951 will be 23·4 per cent greater than that for 1947, and to meet this unprecedented rise the Middle East fields will have to increase production by 100 per cent by that year. From all that transpires in the present "Review of Middle East Oil" there appears to be no reason why this should not happen, particularly as the European Recovery Plan allows for 82 per cent of Western European demands for petroleum being met from Middle East resources in 1951.

Besides the purely economic aspects, technic developments of a high order of efficiency will l essential if the 1951 target is to be reached. In th direction optimism is well sustained, if past histo of this great oil province is anything to go by. Th achievements of the oil companies concerned, no excepting the cultural and social evolution of th native populations, constitute alike a fine record an a model of how things should be done in all spher of exploiting mineral resources in virgin territory The "Review" covers these activities and illustrate them, too, in a most convincing manner. It is a valu able publication, one to be commended to all wh wish to understand the present problem of oil suppl and its vital incidence on international politics these critical times.

H. B. MILNER

CONCENTRATION OF COBALT BY MICRO-ORGANISMS AND ITS RELATION TO COBALT DEFICIENCY IN SHEEP

By DR. J. TOSIC
Rowett Research Institute, Bucksburn, Aberdeenshire
AND
DR. R. L. MITCHELL
Macaulay Institute for Soil Research, Craigiebuckler, Aberdeen

WORK on wasting diseases in Australia[1,2] and New Zealand[3], and 'pining' in the United Kingdom[4,5], has established that cobalt is an essential factor in ruminant nutrition. Deficiency of cobal results in various wasting diseases, the literature of which has been adequately reviewed[6,7,8,9]. In contrast to the ruminant, it appears that non-ruminants, for example, the rat[10] and the rabbit[11], require very little, if any, cobalt in the diet, for they can thrive on diets containing cobalt in concentrations much below those which would cause wasting diseases in ruminants.

Recent work[12,13], in which radioactive cobalt was injected intravenously into adequately fed cattle showed that most of the isotope injected was excrete in the urine, and that only small amounts were foun in the milk and saliva and none in the rumen content radioactive cobalt introduced directly into the rumen was excreted chiefly in the fæces, and none was detected in the blood, saliva or milk, thus suggesting relatively poor absorption of the element. Although it is known that the liver is the storage organ for cobalt in sheep[14] and cattle[13], and that the cobalt content in the liver of a cobalt-deficient sheep is considerably lower than that in a healthy sheep on good pasture[14], the mechanism of the action of cobalt in animal nutrition remains still unknown. Using an as yet unpublished procedure[15] for the separation o rumen micro-organisms and other fractions of the rumen contents, and after chemical concentration applying a spectrographic method[17] to the quantitativ determination of cobalt in the rumen fractions, w have been able to demonstrate that rumen micro-organisms accumulate cobalt from their external environment. Since we find that a large proportion of the cobalt present in the rumen of a sheep i situated in the rumen micro-organisms, it is possibl that in cobalt-deficient sheep the host and the microbial population of its rumen compete for the already low concentration of cobalt available in the feed, and in this way accentuate a deficiency at the place(s) of its physiological function.

In this work we have used three sheep with rumen fistulæ[18]. One, a two-year-old wether (*A*), gained weight on a seeds hay diet (0·27 p.p.m. cobalt in dry matter). The other two wethers, kindly placed at our disposal by Dr. A. T. Phillipson, of the Rowett Institute, and bred originally on a cobalt-deficient pasture, were maintained on a hay diet containing only 0·07 p.p.m. cobalt in dry matter but otherwise adequate. One of these animals (*B*) remained in poor condition (weight at 10 months, 60 lb.) and served as ontrol, while the other (*C*) was dosed daily (during the morning feeding) with 1 mgm. Co (as cobalt hloride) for a period of six weeks. At the end of this period, when sheep (*B*) and (*C*) were about ten months old, rumen contents were collected (10 hr. after last feed) and fractionated. The fractions separated were examined microscopically and were as follows: fraction I, consisting mainly of protozoa and large rod-shaped bacteria, some smaller bacteria occurring singly, in chains, sarcina-like and in other irregular formations, in addition to a fair proportion of finer plant particles; fraction II, similar in microscopic appearance to I but almost completely free from protozoa and plant particles; fraction III, onsisting principally of small cocci occurring mostly singly; fraction IV, consisting of coarser plant particles almost free from micro-organisms adhering to their surfaces; and fraction V, consisting of the supernatant rumen liquid after the separation of fractions I–IV, containing a small proportion of rumen micro-organisms still remaining suspended in the liquid. There was no marked difference in microscopic picture in comparable fractions separated from sheep *A*, *B* and *C*. The total dry matter, and nitrogen, ash and cobalt (on dry matter basis) were determined for each fraction, but for brevity only figures for cobalt are given (Table 1) in this preliminary note.

Our data show that, in the adequately fed sheep (*A*), the cobalt content of the micro-organisms is some three times the cobalt content of similar microbial fractions from the rumen of a sheep (*B*) consuming cobalt-deficient hay. But in sheep (*C*) consuming cobalt-deficient hay and dosed with 1 mgm. cobalt daily, the cobalt content of the microbial fractions is bout five times that of a similar sheep (*B*) receiving no cobalt supplement. When cobalt contents of microbial fractions I, II and III are compared with those for the respective supernatant rumen liquids (cobalt content of which in *A* and *B* is probably contributed mainly by the remainder of suspended micro-organisms and in *C* by the daily dosage of cobalt supplement), and the hay fed, it is apparent that rumen micro-organisms concentrate cobalt from their external environment.

Table 1. Cobalt contents of microbial and other fractions separated from rumen contents of sheep fed cobalt-adequate hay or cobalt-deficient hay with or without addition of cobalt (as p.p.m. Co in dry matter)

Fraction	Sheep fed on:		
	(*A*) Adequate hay	(*B*) Cobalt-deficient hay with no cobalt added	(*C*) Cobalt-deficient hay with 1 mgm. cobalt added daily
Microbial (I)	1·85	0·58	3·51
Microbial (II)	3·81	1·49	5·70
Microbial (III)	3·80	1·55	8·25
Plant particles (IV)	0·19	0·12	4·00
Supernatant liquid (V)	0·12*	0·16*	1·94
Total rumen contents before fractionation	0·67	0·29	2·22
Hay as fed	0·27	0·07	0·07

* Probably due mainly to residual suspended micro-organisms.

Using our results in order to calculate the contribution of each of the separated fractions towards the dry matter of the unfractionated rumen contents, in Table 2 cobalt data are derived for each fraction in terms of micrograms of cobalt per 100 gm. of fresh rumen contents and as percentage recovery from, and distribution in, total rumen content. Good agreement has been obtained between the total cobalt in the rumen contents and the sum of the contributions of the individual fractions. From Table 2 it is seen that most of the cobalt found in the rumen contents is found in rumen micro-organisms (about 80 per cent in undosed animals), and that only a small proportion of the total cobalt is found in the external environment (fractions IV and V), except in sheep *C*, where greater amounts of cobalt were present in the supernatant fluid, due to the daily cobalt dosage.

From our findings it appears that, in sheep, the cobalt content of the microbial population of the rumen is related to cobalt concentration in the diet. If cobalt is essential for micro-organisms, but not for the host, then absorption of the element by the host

Table 2. Distribution of cobalt in separated fractions from rumen contents and contribution of those to the total rumen contents

Fraction	Sheep fed on:					
	(*A*) Adequate hay		(*B*) Cobalt-deficient hay with no cobalt added		(*C*) Cobalt-deficient hay with 1 mgm. cobalt added daily	
	μgm. Co/100 gm. rumen content	% of total rumen content	μgm. Co/100 gm. rumen content	% of total rumen content	μgm. Co/100 gm. rumen content	% of total rumen content
Microbial (I)	1·13	39·5	0·69	52·3	3·67	31·1
Microbial (II)	0·34	11·9	0·10	7·6	0·55	4·7
Microbial (III)	0·95	33·2	0·40	30·3	2·63	22·3
Microbial total	2·42	84·6	1·19	90·2	6·85	58·1
Plant particles (IV)	0·39	13·6	0·22	16·7	1·98	16·8
Supernatant liquid (V)	0·15*	5·2*	0·21*	15·9*	2·49	21·1
Total of individual fractions	2·96	103·5	1·62	122·8	11·32	96·0
Total rumen contents before fractionation	2·86	100·0	1·32	100·0	11·80	100·0

* Probably due mainly to residual suspended micro-organisms.

would deprive the micro-organisms of a factor essential for their growth and/or metabolism. It may even be that pining and other wasting diseases are due to cobalt deficiency of the bacteria, the animal requiring not cobalt but the bacterial products which have thereby become deficient. If cobalt is an essential metabolite for the host alone, then its concentration in micro-organisms may reduce its availability for the host. In this connexion it is of great interest that cobalt has been found to occur to the extent of 4·0 per cent of the crystals (dried *in vacuo*) of the naturally occurring anti-pernicious anæmia factor[19]. It is possible that both the host and the microbial population of its alimentary canal require cobalt for their respective metabolic activities. On a low cobalt diet these competitive relations may assume some importance in the etiology of cobalt-deficiency diseases. How far cobalt found in rumen micro-organisms, after leaving the rumen, can be made available for absorption by the host or for intake by its microbial population in the lower parts of the alimentary canal, and with what result, remains to be shown experimentally, together with the points raised earlier.

Full details of this work involving a study of several trace elements in rumen micro-organisms, and certain pure cultures of bacteria and yeasts, will be published elsewhere.

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LARDER OF THE RED-BACKED SHRIKE

MR. J. H. OWEN has given some interesting information about a bird the habits of which are little known to present generations because the bird has become so scarce (*British Birds*, **41**, No. 7; July, 1948). From observations it would appear that all red-backed shrikes (*Lanius c. collurio*) make larders provided they do not need the catch when it is taken. The male bird seems much more given to 'lardering' than the hen, and as many as six larders may be used by one pair of birds. Usually the larders are not far from the nest, but some have been reported 150 yards away. Often the number of larders is one or two. Shrikes prefer to nest in one of a number of isolated bushes, provided one of them is suitable, rather than in a hedge. Hedgerow larders are usually not at all easy to find. The favourite bushe are hawthorn or blackthorn, especially a part th has been killed by fire or some other means. Th large thorns on rough briars and brambles a frequently used as larders, and occasionally barb wire is also used. Larders often have a considerable number of humble-bees (*Bombus*) in them, often a small bird and, occasionally, a house-mouse (*Mus domesticus*) is found.

Queen humble-bees figure prominently in th larders. The birds usually devour workers and males, carder bees and honey bees (*Apis*) as they catch them. Sometimes wasps (*Vespa*) are taken and the remains found in pellets; but it is rare to find a wasp in a larder. Dor-beetles (*Geotrupes*) and cockchafers (*Melolontha*) are seen pinned up. Insects are usually pinned through the underside of the thorax, bac uppermost; but occasionally some are pinne through sideways or through the back. The victim are often found alive. Larders are more likely to contain food at night than in the morning, and on cold misty mornings the larder that was well stocked at night is often empty. Among the young birds which were found were willow-wrens (*Phylloscopus trochilus*), whitethroats (*Sylvia communis*), linnets (*Carduelis cannabina*), and pipits (*Anthus*), while common lizards (*Lacerta vivipara*), field-voles and wood mice (*Apodemus sylvaticus*) are also taken.

The larder is used for other purposes than feeding. Often the old birds will carry sacs of excrement from the nest and place them on the tips of thorns in a regular larder. This always occurs when pellets are thrown up by the young. Attempts have been made to pin up dead small birds and mammals in the larders. Observations have shown that these have never been pinned up to the satisfaction of the shrikes, and usually a cock bird pulls the bodies free and fixes them elsewhere. There is a certain amount of evidence to show that the hen fetches food from the larder much more than the cock, although he alone may provision it. Both may use it to cram the young before a thunderstorm, for example, or if they have been kept away from the nest for some time.

T. H. HAWKINS

WAVE MECHANICS IN SCIENTIFI RESEARCH

PROF. C. A. COULSON'S inaugural lecture as first professor of theoretical physics at Ki College, London, which he delivered on March 1948, is printed in full in the July issue of *Scie Progress* (**36**, 436; 1948). Taking as his subj "Wave Mechanics in Physics, Chemistry and Biology", Dr. Coulson shows, by several well-chosen examples, that wave mechanics, in spite of its early successe does not provide neat, complete solutions to physical and chemical problems, thus obviatin experimental research; but, as a branch of theoreti physics, is most useful in correlating different piece of information and in bringing out the essentia underlying character of what is observed an measured.

From de Broglie's concept of a particle as a enunciated in 1924, Schrődinger in 1926 treated simple case of the non-relativistic and unpertur hydrogen atom and introduced the wave equa that equation which replaces the ordinary Newtoni equation of motion of the particle. He showed that the rules of quantization were automatically obeyed. The subsequent generalization and wide application of Schrödinger's wave mechanics proved remarkably successful, but there were limitations. One-electron problems or problems with separable variables could be dealt with; but the equations for H_2, the simplest molecular problem, or for the reaction $H + H_2 \rightarrow H_2 + H$, which is the simplest three-electron problem of chemical interest, to say nothing of the more complicated problems of large molecules, are insoluble. These severe limits to the complete calculation of almost any single physical or chemical property led to considerable despondency, and this despondency, it is Dr. Coulson's belief, is due to a wrong conception of the true function of wave mechanics. "Wave mechanics", to quote Dr. Coulson, "is the key—or perhaps *a* key—to the future of physics, chemistry and biology. However, when we open doors with it we do not find completely worked out, neat solutions to all our problems, but new ideas, new principles, new understanding of processes the details of which we shall probably never calculate to 'so many' significant figures, and new relations between apparently unrelated properties."

The examples chosen by Dr. Coulson to illustrate his meaning are taken from fields in which he has made important contributions. They include: atomic and molecular structure, referring briefly to stereochemistry, and to the structure of benzene, which introduces the general phenomenon of 'resonance' and the idea of fractional bond order; electrons in metals, and the understanding of conduction, photo-conduction, fluorescence, etc., which has resulted from the idea of bands of energy-levels but without the band distribution of any single metal ever having been completely calculated; colour; chemical reactions; and finally, the very large molecules from which the nature of life may be determined.

THE HATHERLY BIOLOGICAL LABORATORIES, UNIVERSITY COLLEGE, EXETER

By Prof. JOHN CALDWELL

THE foundation stone of the Hatherly Biological Laboratories of the University College of the South-West, Exeter, was recently laid by the Marquess of Salisbury, president of the College, in presence of representatives of the County, the City and the College. When the building is completed, as it is hoped, within the next two years, it will accommodate the Departments of Botany and Zoology, which are, at present, housed in very inadequate and cramped quarters in the Old College buildings in the centre of the city.

The War has, of course, greatly impeded the development of the College as regards buildings, and the estate which the College acquired some twenty-five years ago affords great opportunity for building development, though inevitably that development must be temporarily delayed. It is fitting, therefore, that the first of the post-war buildings should be for the Biological Departments in a college which serves primarily an essentially agricultural area, so that these Departments may have adequate space for the development of their work in the service of the community.

The erection of the Laboratories has been made possible by a bequest of the estate of Mrs. Heath, supplemented by grants from the University Grants Committee. The teaching and research work of the biological departments has expanded very greatly from the time of the appointment of the late J. L. Sager as head of the Department of Biology in the Royal Albert Memorial College in 1907. The scope of the Department increased rapidly right from the beginning, and in 1928 a Department of Zoology was set up under Dr. G. Lapage, who was succeeded on his appointment to Cambridge by Mr. L. A. Harvey, the present head of the Department of Zoology. Mr. Sager continued as head of the Department of Botany until his retirement in 1935, when he was succeeded by the present writer, who had previously been on the staff of the Department of Plant Pathology at Rothamsted Experimental Station. Both Departments in the College, as is common to all university departments at present, are overcrowded and badly in need of additional accommodation.

When the new Laboratories are completed, each Department should have adequate accommodation for reasonable expansion. Each will have three large main laboratories and a small laboratory for honours students, with adequate private rooms, preparation and lecture rooms. There will also be a large lecture room, museum accommodation and dark rooms, tank and constant-temperature rooms for general use.

The building, which is designed by Mr. E. Vincent Harris, is in the form of a main block with private rooms and caretakers' quarters on the front, with five bays running back from it in which are situated the laboratories. This arrangement will allow of the maximum of light being available in the laboratories without having a south exposure.

As the site is on the College estate on the outskirts of the city, there is a considerable amount of ground available behind and around the building, which it is proposed to lay out for botanical collections and experimental ground with glasshouses. The whole should eventually form an ideal unit for biological investigation and teaching. The Departments have now, even under the present conditions, a wide range of research work on hand. On the botanical side, various aspects of virus diseases are being studied, both on the more general side and on diseases of specific crop plants common in the region.

Other phytopathological work includes the study of the ecology of fungi in relation to plant disease, investigation of the Erysiphales, and of the rust of *Chrysanthemum* and similar studies. The cytology of various plants is being investigated as well as more general cytogenetical subjects. At the same time there is a considerable amount of work being done on the cultivation of various plants of some economic importance, and a study of their anatomy and physiology in relation to different cultural methods. It is hoped also to expand and develop an ecological survey of a portion of Dartmoor.

On the zoological side investigations are being carried out on the ecology of areas in the south-west with special reference to Lundy, on some aspects of parasitic protozoology and on some problems of human fertility.

FORTHCOMING EVENTS

(*Meeting marked with an asterisk * is open to the public*)

Tuesday, September 28

Eugenics Society (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. Paul Bloomfield: "The Eugenics of the Utopians; the Utopia of the Eugenists".*

Tuesday, September 28—Thursday, September 30

Society of Chemical Industry (at the University, Leeds).—Conference on "Dust in Industry".

Tuesday, September 28

At 9.30 a.m.—"Physical Characteristics and Estimation of Dust"; at 2.30 p.m.—"Practical Aspects of the Dust Problem", Part 1.

Wednesday, September 29

At 9.30 a.m.—"Practical Aspects of the Dust Problem", Part 2; at 2.30 p.m.—"Fire and Explosive Hazards".

Thursday, September 30

At 9.30 a.m.—"Health Hazards"; at 2.30 p.m.—Summation of the Work of the Conference.

Wednesday, September 29

Television Society (at the Royal Institution, Albemarle Street, London, W.1), at 6.30 p.m.—Mr. Arthur Blok: "Some Personal Recollections of Sir Ambrose Fleming" (Third Fleming Memorial Lecture).

Society for Visiting Scientists (joint meeting with A.S.L.I.B., at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Dr. F. R. Ranganathan: "Self-Perpetuating Classification—the Need and Possibility".

Wednesday, September 29—Thursday, September 30

Institute of Welding.—Autumn Meeting.

Wednesday, September 29

At 2.30 p.m. (at the Institution of Civil Engineers, Great George Street, London, S.W.1).—Discussion on "Technical Training for the Associate-Membership Examination of the Institute" (to be opened by Mr. T. R. B. Sanders).

Thursday, September 30

At 10.30 a.m. (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1).—Dr. H. G. Taylor: "Some Aspects of Welding Research in Great Britain and America" (Session arranged by the British Welding Research Association); at 2.30 p.m.—Discussion on "The Training of Welders" (to be opened by Mr. F. Clark, Mr. S. W. Carpenter and Mr. R. J. Fowler): at 6 p.m.—M. André Goelzer: "Repair and Reinforcement of Metal Bridges by Welding".

Thursday, September 30

Royal Aeronautical Society (at the Institution of Civil Engineers, Great George Street, London, S.W.1), at 6 p.m.—Mr. Peter G. Masefield: "Some Economic Factors in Civil Aviation, with Emphasis on Civil Aircraft and their Prospective Trends of Development" (Fourth British Commonwealth and Empire Lecture).

Royal Statistical Society, Sheffield Group of the Industrial Applications Section (in Room B1, Department of Mechanical Engineering, The University, St. George's Square, Sheffield), at 6.30 p.m.—Symposium on "The Limitations of Statistical Methods".

Saturday, October 2

Society of Public Analysts and other Analytical Chemists, North of England Section (joint meeting with the Physical Methods Group, at the Stork Hotel, Queen Square, Liverpool), at 2 p.m.—Scientific Papers.

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Technician to take charge of the Medical Unit Laboratory—The Secretary, St. Mary's Hospital Medical School, Praed Street, London, W.2 (October 1).

Scientific Officer (male) for work on cereal breeding, a Scientific Officer for work dealing with virus diseases of potatoes, and a Scientific Officer to work in collaboration with other members of the plant breeding staff on genetical and cytological problems—The Secretary, Scottish Society for Research in Plant Breeding, 8 Eglinton Crescent, Edinburgh 12 (October 2).

Lecturer (man or woman) in Agricultural Sciences, and a Lecturer (man) in Agriculture (farm implements, building construction, etc.), at the Cheshire School of Agriculture, Reaseheath, Nantwich—The Director of Education, County Education Offices, City Road, Chester (October 2).

Responsible Lecturer in Mechanical Engineering, a Lecturer in Mechanical Engineering, and a Lecturer in Mathematics for engineering students—The Principal, Royal Aircraft Establishment Technical College, Farnborough, Hants (October 2).

Assistant Agricultural Economist *or* an Investigational Officer and Clerk Accountant—The Registrar, The University, Leeds 2 (October 4).

Research Assistantships (2) for work on (*a*) physical and chemic aspects of selective flotation, and (*b*) mining research problems—Th Registrar, The University, Leeds 2 (October 4).

Assistant Advisory Officer in Agricultural Botany—Th Secretary, Edinburgh and East of Scotland College of Agricultur 13 George Square, Edinburgh 8 (October 9).

Laboratory Technician in the Department of Organic Chemistry—The Registrar, The University, Liverpool (October 9).

Mechanical and Electrical Engineers in the Higher Departmental Grades in the Ministry of Supply—The Secretary, Civil Servic Commission, Scientific Branch, 27 Grosvenor Square, London, W (October 12).

Research Officer to undertake research and assist in the wor of the Photometry Laboratory (Ref. No. 1917), a Research Office to assist in physical investigations at low temperatures (Ref. N 1918), and Research Officers (2) to undertake research on th physical properties of wool fibres and related materials (Ref. No 1919 and 1920), in the C.S.I.R. Division of Physics, Sydney—Th Chief Scientific Liaison Officer, Australian Scientific Research Liais Office, Africa House, Kingsway, London, W.C.2, quoting the appr priate Ref. No. (October 16).

Research Officer in the C.S.I.R. Division of Industria Chemistry, Melbourne, to assist in the X-ray crystallographi investigations of the Division's Chemical Physics Section—The Chi Scientific Liaison Officer, Australian Scientific Research Liaison Offic Africa House, Kingsway, London, W.C.2, quoting Ref. No. 191 (October 16).

Brotherton Research Fellowship in Physical Chemistry and the Bradford Dyers' Association Research Fellowship—Th Registrar, The University, Leeds 2 (October 18).

Assistant Professor in Inorganic Technology at the Facult of Engineering, Fouad I University, Giza, Egypt—The Directo Egyptian Education Bureau, 4 Chesterfield Gardens, London, W. (October 18).

Mechanical Production Engineer, and Mechanical Desig Engineers (2), for the G.P.O. Engineering Department (Researc Branch), Dollis Hill, N.W.2—The Secretary, Civil Service Commissio Scientific Branch, 27 Grosvenor Square, London, W.1, quoting N 2288 (October 21).

Technicians (2) in the Engineering Research Laboratory Technicians (4) in the Standards Laboratory; a Senior Mec anical Draughtsman and Mechanical Draughtsmen (2) in th Design Section; a Technician in the Workshops Planning Section Toolmakers (4) in the Machine Room, and a Leading Hand Too maker and a Toolmaker in the Grinding Room, of the Precisio Metal Workshop; a Technician in the Electrical, Electronics an Acoustics Laboratory; and Technicians (2) in the Instrumen Testing and Development Section; of the Dominion Physical Lal oratory at Wellington—The Office of the High Commissioner for Ne Zealand, 415 Strand, London, W.C.2 (October 30).

Life Fellowship in Botany—The Registrar, Trinity Colleg Dublin (January 1).

Entomologist in the Medical Department (Sleeping Sicknes Service), Nigeria—The Director of Recruitment, Colonial Servic Sanctuary Buildings, Great Smith Street, London, S.W.1.

Works Chemist to undertake production and/or developmen responsibilities on shift work (if necessary) in a chemical factory the Department of Atomic Energy, Springfield's Factory, Salwic Preston—The Staff Section, Ministry of Supply, Department of Atom Energy, Risley, Warrington, Lancs.

Technicians (2, Grade III) in the Department of Botany-The Secretary, University College, Gower Street, London, W.C. quoting "Botany/1".

Laboratory Technician (Grade B) in the Department o Pharmacology—The Secretary, Medical College of St. Bartholomew Hospital, West Smithfield, London, E.C.1.

Senior Research Worker (with extensive experience in mod biochemical or experimental physiological methods as applicable research in psychiatry)—The Medical Superintendent, Bristol Ment Hospital, Fishponds, Bristol.

Physical Chemist or a Physicist to undertake fundamental wor on metal finishing problems including electrodeposition and electr polishing—The Secretary, British Non-Ferrous Metals Researc Association, 81–91 Euston Street, London, N.W.1.

Instrument Makers (2, Grades I and II) in the Department o Electrical Engineering—The Secretary, University College, Gow Street, London, W.C.1, quoting "Elec. Eng./1".

REPORTS and other PUBLICATION

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

Report of the Ministry of Health for the Year ended March 31st, 194 including the Report of the Chief Medical Officer on the State of th Public Health for the Year ended 31st December, 1946. (Cmd. 7441 Pp. viii+204. (London: H.M. Stationery Office, 1948.) 3*s*. 6*d*. net. [187

Quarterly Bulletin of the British Psychological Society. Vol. 1, No. 1, July 1948. Pp. 36. (London: British Psychological Society, 1948.) [197

Metallurgical Abstracts (General and Non-Ferrous). Vol. 13, 1946 (New Series). Edited by S. C. Guillan. Pp. viii+553. (London Institute of Metals, 1946.) £3. [19

Catalogues

Technique, a Journal of Instrument Engineering. Vol. 2, No. July. Pp. 17–24. (Beckenham: Muirhead and Co., Ltd., 1948.)

Sunvic Evacuated Bimetal Switches. (MS. 10a.) Pp. 2. (London Sunvic Controls, Ltd., 1948.)

VHF Direction Finder with Remote Control and Presentation (Ref. SL. 34.) Pp. 4. Marconi Broadcasting. (Ref. SP. 12.) Pp. 12. (Chelmsford: Marconi's Wireless Telegraph Co., Ltd., 1948.)

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